NOTES

TO

ASSIST THE MEMORY

IN

VARIOUS SCIENCES.

Condensation is the result of time and experience, which reject what is no longer essential.

SECOND EDITION,

CORRECTED AND ENLARGED.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
MDCCCXXVII.

LONDON:

PRINTED BY C. ROWORTH, BELL YARD

TEMPLE BAR.

PREFACE.

The following Notes were originally collected to assist a most stubborn and capricious memory, which retained nothing if studied systematically or by any tedious process, yet could readily apprehend distinct facts and principles if disencumbered of all superfluous words, and subsequently, by a sort of mental re-action, connect and digest them. Truths, however remote in appearance, have among themselves a necessary relation and connexion, extremely favourable to the powers of memory and apprehension, whereas errors are commonly so many insulated propositions. Had the author, in preparing them for publication, adopted the method which he practically found most beneficial, he would have arranged them at cross purposes, making each successive Note a perfect contrast to its predecessor; but as this

species of regular confusion might not have suited a majority of readers, and would at the same time have increased the difficulty of reference, he has thought it preferable to distribute them under certain general heads, but without any particular anxiety as to their being strictly within the legitimate boundaries of the science designated.

The sources from which a considerable portion of these Notes are derived will be easily recognized, although some have been re-constructed to keep pace with the progress of discovery, and others modified to suit the compiler's own view of the subject. But all pretensions to originality are disclaimed, the grand object having been to condense and simplify *from every source* such useful and interesting facts and principles as are likely to adhere to the memory of even the most careless reader, and to which, like points of departure in navigation, he might when at a loss appeal for correction. The intellectual faculties, being thus called into action by a single effort, are likely to exert a much more energetic vigour of reflection, than if intercepted by a prolix commentary or verbose illustration, and many who, like the

author, might be able and willing to comprehend a part, would turn away in despair from the complexity of the whole. On each Note the reader will of course pause, draw his own inferences, and acquiesce or dissent according to the degree of conviction they impress on his judgment. Some have been inserted more to stimulate curiosity and promote discussion than as established truths; for a valuable hint may be thrown out by one incapable of forming a regular system, and as the mind expands we gradually discover how much remains to be known.

INDEX

TO THE

TABLE OF CONTENTS.

TABLE OF CONTENTS.

ASTRONOMY.

MATHEMATICS.

METAPHYSICS.

MORAL PHILOSOPHY.

ELECTRICITY.

GALVANISM.

MAGNETISM.

VARIATION OF THE COMPASS.

PNEUMATICS.

MECHANICS.

HYDROSTATICS.

POLITICAL ECONOMY.

STATISTICS.

NAVIGATION.

WAR.

GEOGRAPHY, HYDROGRAPHY, &c

POPULATION.

CHEMISTRY.

LAW, POLITICS, &c.

BOTANY.

AGRICULTURE.

ZOOLOGY.

ENTOMOLOGY.

ANATOMY, PHYSIOLOGY, AND MEDICINE.

OPTICS.

GRAMMAR.

GENERAL LITERATURE.

MUSIC.

THE FINE ARTS.

MINERALOGY.

GEOLOGY.

NOTES

ON VARIOUS SCIENCES.

ASTRONOMY, &c.

Astronomy is a mixed mathematical science, teaching the knowledge of the celestial bodies, their magnitudes, motions, distances, periods, eclipses, and order.

Celestial Objects seen where they are not.

Notwithstanding the rapid motion of light, (170,000 miles per second,) it is evident that if a luminous body were suddenly placed in the heavens, at (for example) the same distance as the sun is from us, we could not possibly see it before the lapse of 8¼ minutes.—The consequence of this interval is, that when we behold a celestial object, we do not see it in the place where it actually is, but in the place where it was some time before.

Herschel thinks the light of some of his distant nebulæ (now visible with telescopes) would be 48,000 years in reaching us.

Gravity possibly not instantaneous.

It has been observed that most of the agents we are acquainted with require time to pass from one point of space to another; the force of *gravity* may also be of this nature, and may not, any more than light, be instantaneously transmitted from the sun to the planets, or from the planets to one another.

Is attraction a virtue propagated in time or not; and if so, does it travel quicker or slower than light?

The Solar Spots.

Sir William Herschel attributes the spots on the sun to the emission of an aëriform fluid, not yet in combustion, which displaces the great luminous atmosphere, and which is afterwards itself to serve the purpose of supporting combustion. Hence he supposed the appearance of copious spots to be indicative of the approach of warm seasons on the surface of the earth, and he has attempted to maintain his opinion by historical evidence.

Light.

At the depth of 723 feet through sea water, according to Bouguer, light ceases to be transmitted, and probably at three times that depth there is perpetual darkness.

Only one hundred thousandth's part ($\frac{1}{100,000}$) of the vertical rays of the sun can penetrate below 47 fathoms; the depths of the ocean are consequently involved in perpetual darkness.

The most remarkable property of light is its velocity.

A peculiar Light.

Moses says that the light was first formed and that was the first day.—On the third day after this, the

sun and moon were formed.—As we have now no light, but what comes either from the sun himself, or by reflection from the moon; and as there was light and also day and night before the sun and moon were formed, we must infer that the day here mentioned has been of a different character from our day, and that this light had a different source from an immediate communication with the sun.—We may therefore conclude that during the incipient formation of our planet, it possessed a light peculiar to its own constitution, which appears also to accompany other heavenly bodies, such as comets, in a similar stage of their formation.

The Light and Revolution of Comets.

When comets are advancing towards their perihelium, and at different distances approach nearer the earth, we observe that they are not only surrounded by a luminous atmosphere, but have a long luminous tail, both of which become greater as they approach the sun, and decrease as they recede from him.—In the case of some, almost the whole mass is changed into this luminous atmosphere and tail; in others we perceive a distinct red nucleus, which on approaching the sun becomes a less expanded atmosphere and tail.—Bessel calculated the period of the revolution of the comet of 1811 to be 3,383 years; Sir William Herschel made the radius of its atmosphere 322,000 English miles, and the length of its tail more than 100 millions of miles.—He also believed that it revolved on its axis, and that during each perihelium they approached nearer and nearer to the sun, while their orbits approached nearer and nearer to the circular form.—A remarkable comet is expected in 1835.

A Comet's Tail.

It must be admitted that before a comet can have

a tail, it must necessarily always present the same side to the sun. Some comets show no trace of a tail, while others acquire one near their perihelium. The comet of 1816 was supposed to deviate 72° from the ecliptic.

Comets distinguished from Planets.

Comets are distinguished from planets by revolving in much more eccentric orbits; their periods of revolution are very different from one century to another; their distance and proximity to the sun are so great that they must be at one time congealed, and at another melted, if they resemble earthly substances.

The little Planets, or Asteroids.

Diameter of Ceres (or the Piazzi) 161 miles.*
Ditto of Pallas (or the Olbers) 100

The astronomer Piazzi had the merit of discovering a new planet, and was the first to observe several comets, while his minute classification of the stars has been the cause that Pallas, Juno, and Vesta have been discovered. With regard to these Asteroids, as they are all between the orbits of Mars and Jupiter, and similar in their mean movements, a speculation has been advanced among the scientific, that they are the component parts of a ruined planet.

Precession of the Equinoxes.

The sun, which was in the Ram in the time of the Argonauts, is now in the Bull.

This motion is called the "Precession of the Equinoxes," because by it the time and place of

* Ceres is about the size of Ireland, which would make a similar appearance, were it dug out of the ocean, and projected into the air.

the sun's equinoctial station *precede* the usual calculation. The precession is equal to $=50''\frac{1}{3}$ annually moving westward.

Exact Length of the Year.

When two equinoxes at the distance of 60 years were observed, the interval was found to be nearly 21,000 days.

The exact length of the year is 365 days, 5 hours, 48 minutes, 51 seconds, 6 decimals.

An astronomer thinks he commits no error, when he considers the rate of the sun's motion as uniform (which in reality it is not) for 24 hours.

The Earth's Annual Revolution an Uncertain Measure of Time.

Notwithstanding the earth's annual revolution round the sun we cannot ascertain its real duration; for although this should continue for 365¼ days without change, every day, every hour, and every second may be proportionally shorter, without our being able to discover it. La Place computes that since the time of Hipparchus, the year has become some few seconds shorter. Possibly the change was greater at first, diminishing as the earth's orbit approached a true circle.

The Relative Length of the Seasons.

M. Biot endeavoured to show how the position of the Apsides affects the relative length of the seasons—thus—

	Days
It has been computed that in the year 1800, from the vernal equinox (the 21st March) to the summer solstice (the 21st June) was	92·90588
From the summer solstice to the autumnal equinox (the 21st September)	93·56584
From the autumnal equinox to the winter solstice (the 21st December)	89·69954
From the winter solstice to the vernal equinox (the 21st March)	89·07110
Days,	365·24236

The spring therefore is now shorter than the summer, and the autumn longer than the winter.

So long as the solar perigee remains on the side of the equator where it now is, the spring and summer taken together will be longer than the autumn and winter taken together.—In the present age the difference is about seven days as appears from the preceding values. These intervals, however, will become equal about A. D. 6485, when the perigee will reach the vernal equinox; afterwards it will pass beyond it, and the spring and summer taken together will become shorter than the autumn and winter.

Such phenomena could not obtain if the motion of the sun were circular and uniform, as then all the seasons would be equal. The eccentricity of the orbit therefore, although very small, has a sensible influence on the duration of the seasons, and the displacement of the major axis, though very slow, produces variations which become perceptible in distant ages.

The Harvest Moon.

The year 1818 was the third of a series of ten

years, during which the moon will prove beneficial to the farmer for reaping and gathering in the fruits of the earth; viz. from 1816 to 1825 inclusive. The preceding nine years, namely, from 1807 to 1815 inclusive, were, from natural causes, of the class in which the harvest moon was least beneficial, such will also be the years from 1826 to 1882.

Spring and Neap Tides.

The forces of the moon and sun's attraction are to each other as 51 to 10; the sum and difference of these numbers are 61 and 41, and therefore the spring tides caused by the sun will be to the neap tides as 61 to 41, or 6 to 4; that is, the first are one third greater than the last.—If the sun therefore can raise the tide 1 foot 11 inches, the moon will raise it 9 feet 11 inches, and both together, during the spring tides, about 11½ feet, but in neap tides only about 7½ feet. This furnishes a general notion of the tides, which, however, admits of much variety and many exceptions from local and other circumstances.

Old and New Style.

Since the commencement of the present century, the difference between the old and new style is 12 days, another day in addition to the prior 11, having been thrown out in the year 1800, by assigning to February only 28 days.*

Golden Number.

Meton discovered that 19 years contain 235 lunations, (within 2½ hours;) so that, at the end of 19 years, the solar and lunar years began again on the

* This loss of a day to the whole civilized world, was scarcely remarked at the time.

same day their cycle of 19 years. Hence the number that denotes the current year of that number, is denominated the *Golden Number*, having been marked by the Greeks with letters of gold.

Easter Day.

Easter Day is always the first Sunday after the full moon, which happens upon, or next after the vernal equinox (the 21st of March).

The Laws of Kepler.

1. The first is, that the planets all move in elliptical orbits, having the sun for their common centre.
2. That round this focus the radius vector of each planet describes equal areas in equal times.
3. That the squares of the periodical times of the planets are as the cubes of their mean distances from the sun.

The two greatest Astronomical Discoveries.

After Newton's discovery of the elliptic orbits of the planets, La Grange's discovery of their periodical inequalities is, without doubt, the noblest truth in physical astronomy; and with respect to the doctrine of final causes, it may be regarded as the greatest of all.*

Universal Influence of Gravity.

In any system, (our solar, for instance,) the component parts of which are all free to move or be at rest, and which are governed by the usual laws of gravitation, the instant that any one of them is in motion, the others cannot remain quiescent.

A projectile force is assumed, as impressed on all bodies found revolving round others.

* Copernicus's true theory of the solar system, was a discovery of the first magnitude, but it was only theory not demonstration.

Obliquity of the Ecliptic.

It was demonstrated by Euler, that the change in the obliquity of the ecliptic is periodical; that it is not a constant diminution, but a small and slow oscillation on each side of a mean quantity, by which it alternately increases and diminishes in the course of periods which are not of the same length; but by which, in the course of many ages, a compensation ultimately takes place.

Inequalities of the Planetary Orbits.

La Grange found, that the inequalities produced by the mutual action of the planets must in effect be periodical; and that amidst all the changes which arise from their mutual action, two things remain perpetually the same; viz.

The length of the greater axis of the ellipse described by the planet, and its periodical time round the sun; or, which is the same thing; the mean distance of each planet from the sun, and its mean motion, remain constant.

The elliptical figure of a planet's orbit never alters as to length, but only in breadth, bulging out for a series of years, returning gradually to its original figure, and then bulging out again.

Eccentricity of the Planetary Orbits.

The orbits of the planets are all ellipses, having the sun for their common focus, and the distance of the focus from the true centre of the ellipse, is what astronomers call the "*eccentricity of the orbit.*"—In all the planetary orbits this eccentricity is small, and the ellipse approaches nearly to a circle.—These eccentricities, however, continually change in the progress of time, although very slowly; but in such a manner, that none of them can ever become great. They may vanish or become nothing, when the orbit

will become nearly circular.—In this state, however, it will not long continue; but in the course of ages again return to the form of an ellipsis, of an eccentricity that will vary as before, so as never to exceed a certain limit.*

Stars of a Variable Lustre.

There are particular stars that shine with a variable and periodical lustre, white, yellow, blue, and red, with all their different shades.—Baron Zach has published a catalogue of 28 of these changeable stars.

The star Algol, the most remarkable of the variable stars, when its light is smallest, appears of the fourth magnitude, but when brightest, of the second. The complete change appears to occupy a period of only eight hours.

Great Weight of the Solar Inhabitants.

As the diameter of the sun (883,000 miles) is 111 times greater than that of the earth, a body at its surface would fall through 450 feet in a second of time; so that if there be any human inhabitants residing there, each individual of moderate size must weigh at least two tons.

The bulk of the sun is 1,300,000 greater than that of the earth.

The Moon.

The moon when viewed through a good telescope, has the appearance of an incinerated mass.

* It is remarkable that the only facts perfectly certain are those relating to the motions of the heavenly bodies, which are nevertheless so many millions of miles removed from our immediate cognizance; over every thing else there hangs a cloud of doubt and mystery.

All instances of celestial motion are instances of curvilinear motion.

This luminary, being fifty times smaller than the earth, with only the seventieth part of its attractive power, has five sevenths of the earth's density, and is consequently about four times denser than water.

There is no appearance of any water in the moon, nor of any atmosphere; if any creatures, therefore, live in the moon, they must be very differently constituted from the occupiers of the earth.

Satellites always present the same face to the planet.

Lunar Irregularities.

The accumulation of matter in the equatorial regions, modifies the action of the earth upon the moon, insomuch, that the motion of the latter is affected by two irregularities, one in the latitude and the other in the longitude. There are also other causes of the lunar irregularities.

Date of the Hindoo Astronomical System.

La Place has observed that the mean motions which any system of Astronomy assigns to Jupiter and Saturn, give us some information concerning the time when that system was formed. Thus the Brahminical Hindoos seem to have formed their system when the mean motion of Jupiter was the slowest, and that of Saturn the most rapid; and the two periods that fulfil these conditions, come very near to the year 3102 before the Christian era, and to the year 1491 after it; both remarkable epochas in the Astronomy of Hindostan.

Hindoo Yugs.

The Hindoo yugs and periods were astronomical contrivances, resting at one end on observations taken at the time they were invented, and at the other on some period so very remote, that the greatest possible error in the position of the planets at the time

referred to (which could never exceed six signs of longitude) must become almost insensible in their annual revolutions, and unimportant until a great number of years intervene, either before or after the invention.

Density of Comets, or the reverse.

The small eccentricity of the planetary orbits, and the motion of the planets in the same direction, are essential to the stability of the system, yet the comets, which obey neither of these laws, do not affect that stability. Some disturbance would no doubt be caused by the comets that pass through our system were they bodies of great mass, or contained a great quantity of matter; but there are many reasons for supposing them to have very little density, so that their power to produce any deviation in the planetary orbits is wholly inconsiderable.

On the 9th Nov. 1795, Sir William Herschel saw a double star of the 12th or 13th magnitude, through the middle of a comet, with very little diminution of its brightness.*

The nucleus of a comet has so little density, that even when in proximity to a planet, it exercises no appreciable attraction on it. The comet of 1770 approached the earth to a distance of only seven times greater than that of the moon, without producing any sensible action on it.

Satellites of Jupiter.

Although the satellites of Jupiter have only been known since the invention of the telescope, about two centuries ago, yet within that period, the quickness of their revolutions has exhibited all the changes

* Every observation made on comets tends to strengthen the suspicion, that so far from being burning bodies, they are masses of transparent fluid having very little density.

which time developes so slowly in the system of the primary planets. Abundance of materials have therefore been collected for a comparison between fact and theory.

Grand Conjunction.

In 1748 the attention of astronomers was attracted to the conjunction of five planets, in one sign of the zodiac,—a phenomenon that had not before occurred since the creation of the universe.

Number of Stars.

Of the stars in the British catalogue, there are many only visible through a telescope, nor does the eye ever see more than a thousand at the same time in the clearest heaven; yet the number is probably infinite. From the first to the sixth magnitude, inclusive, the total number of stars is 3,128.

The Zodiac.

The sun never deviates from the ecliptic or middle of the zodiac; the planets all do, more or less. Their greatest deviations, which never exceed 20 degrees, form the extreme breadth of the zodiac. The zodiacal light is supposed to be the visible substance of the solar atmosphere.

The Chaldean Cycle.

Thales is supposed to have made some of his discoveries by the help of the Chaldean cycle, called Saros. This cycle consisted of 6585⅓ days, or 223 lunations, or 18 years, 15 days, and 8 hours; after which the Chaldeans imagined, from a long series of observations, that the eclipses of the sun and moon returned again in the same order and quantity as before.

Theory of the Milky Way or Galaxy.

Sir Wm. Herschel considers the milky way to be an extensive branching congeries of stars, within

which our own solar system is placed; the luminous tracts that constitute the galaxy being a projection of the nebulæ on the concave surface of the sky, as seen from the solar system which it incloses.

Comparative Distance of the Fixed Stars.

The same great astronomer concluded, that a star of the first magnitude would just become visible to the naked eye if removed to 12 times its present distance, and by the most powerful telescope if removed to 2300 times that distance.

Motion of what are called the Fixed Stars.

A change of place (a deviation to the south) in the declination of some of the principal fixed stars, Mr. Pond thinks is taking place.

Binary Systems.

Mr. Herschel and Mr. South have clearly established the existence of binary systems, in which two stars perform to each other, the offices of sun and planet. They have ascertained the periods of rotation of more than one pair, and have also observed the occultations of stars behind each other, and the motions of revolving systems, detecting among them real motions sufficiently rapid to become measurable quantities in very short intervals of time.

Figure of the Earth.

The equatorial diameter of the earth is to the polar diameter as 179 to 178, and the equatorial radius of the earth about eight leagues longer than the polar.

Length of the Pendulum.

The following are some of the difficulties that

occur in ascertaining the exact length of the pendulum:—

The various expansion of metals, respecting which scarcely two pyrometers agree; the changeable nature of the atmosphere; the uncertainty as to the true level of the sea; the extreme difficulty of measuring accurately the distance between the point of suspension and the centre of oscillation, and even of finding that centre. Besides these, another source of error has been lately discovered, which seems to remove all hope of perfect accuracy; viz. the variety of terrestrial attraction, from which cause the motions of the pendulum are also liable to variation, even in the same latitude. In pursuing his researches Capt. Kater discovered that the motions of the pendulum are affected by the nature of the strata over which it vibrates.

The length of the seconds' pendulum may be demonstrated to be exactly in proportion to the force of gravity at the place of observation.

Vibration and Length of the Pendulum.

It had long been a desideratum to ascertain the number of vibrations which would be made by a certain pendulum, within a given time, were it placed at the level of the sea in vacuo, and at a certain temperature. This was established in 1820 and subsequent years, and the following statement resulted: viz.—

			Inches.
Length of a pendulum vibrating seconds in vacuo in 51° 31′ 8″ 4 N., the latitude of London, at the temperature of 62° Fahr. - - - - -			39,13929.
Ditto	ditto	at Brassa - - - - - -	39.16929.
Ditto	ditto	at Hare Island - - - -	39.1984.
Ditto	ditto	at Melville Island, Polar Sea -	39.207.
Ditto	ditto	at the Galapagos Isles, lat. 0.32 N.	39.01719.
Ditto	ditto	at St. Blas, lat. 21.30 N.	39.00904.
Ditto	ditto	at Rio Janeiro, lat. 22.55 S.	39.01206.

The French Metrical System.

All the measures of the French metrical system rest upon one sole base, supposed to be found in nature, viz. the quarter of the terrestrial meridian; and the division of these measures is subjected to the decimal order employed in arithmetic.

The result of operations carried on to measure the meridian which traverses France, has given 57,027 French toises for the length of the degree, from whence, for the 90 degrees composing the quadrant of that arc, 5,132,430 toises are found. The last quantity, divided by ten millions, gives a length of 3 feet, no inches, 11 lines, and 44 hundredths (3 : 0 : 11 : 44), which has been fixed on as the prime unit of linear measure, and named the metre.* The Paris foot is to that of London as 864 to 811, or as 16 to 15 nearly.

In the calculation of these measures, by proceeding a maximis ad minima, and thus still dividing, and consequently still diminishing any error, the further we proceed, it will in the end, when we come to ordinary measures, such as feet, become for practical uses quite insensible.

No two Portions of any Meridian exactly similar.

The French linear measures of the ten-millionth part of a quadrant of the meridian has been found full of absurdities and defects, it having been ascertained that no two portions of any one meridian on

* Notwithstanding the pains taken and vast expense incurred, the French metrical system has wholly failed of success in practice, and never was generally adopted. It was found that the common people could not be brought to understand the division by ten, nor to adopt the Greek terms then introduced. The consequence has been, that there is now a greater diversity of weights and measures than existed antecedent to the new system, which was to produce perfect uniformity.

different sides of the equator are either similar or equal; the true measurement has consequently given a diversity of results.

Mild Springs.

The series of mild springs which ended about the years 1785 or 1786, seems to have begun at least as early as 1749, and to have lasted thirty-six years. Our present series of cold springs has yet lasted only twenty-three years, and of course we have thirteen bad years to come.

The Planet Tellus.

The earth (Tellus) is one of eleven spherical bodies denominated planets, which revolve round the sun, its distance from which luminary being 93,595,000 English miles, and its mean diameter 7912 miles. It completes its diurnal revolution in 24 hours, and its annual revolution in 365 days, 5 hours, 48 minutes, 51″. One satellite (the moon), 2180 miles in diameter, revolves round the earth in 27 days, 7 hours, and 43 minutes, at a mean distance of 237,000 miles.

The Dog Days.

From the heliacal rising of the dog-star (Sirius), that is to say, its emersion from the sun's rays, which now happens about the 11th day of August, the ancients reckoned their dies caniculares or dog-days.

Density of the Earth.

The precession of the equinoxes, and the nutation of the earth's axis, indicate, in the opinion of Laplace. that the density of the earth increases towards the centre. Mr. Cavendish, from some experiments made with leaden balls, estimated the mean density of the earth at 5.48; but the experiments at Schihal-

lieh, in Scotland, give the mean density equal to 4.71, that is about $4\frac{3}{4}$ times the weight of an equal bulk of water. But as the mean density of the rocks at the surface does not exceed 2.5 or 2.7, it follows that the density of the central parts must be much higher.

If, for instance, the exterior rocks form a shell 500 miles in thickness, the parts within this shell would require to have an average specific gravity of 5.8 to produce the mean density of 4.7 for the whole mass.

Laplace thinks that the change is not sudden, but progressive, and that it is probably the effect of concentric and elliptical beds of increasing density. A conjecture may be ventured that metals occupy the centre of the earth, and that those found in the outer crust consist of minute portions cast up from the central mass.

It is probable that the structure of the external portion of our planet, exposed to observation by various circumstances, does not extend four or five miles; the variation of the magnetic needle, however, would lead us to infer that it is not an inert mass, but rather a well-constructed machine in which regular processes are taking place, conducive to its own stability and future renovation.

Compression of the Poles.

Capt. Sabine's calculation gives $\frac{1}{288\frac{1}{2}}$ for the compression of the Poles, a very remarkable result, in consequence of its being the same that expresses the ratio of the centrifugal to the gravitating force. When we consider this we cannot help believing that there is some connexion between the external figure of the earth and its internal constitution.

$\frac{1}{288}$ differs from all prior results, but is entitled to the highest confidence. Indeed the singular coincidence that from time to time has been found between

the deductions obtained from the pendulum and actual measures of arcs, when used to confirm each other, is rather remarkable. The French commission inferred an ellipticity from measurement of $\frac{1}{336}$; Laplace calculated the compression from fifteen lengths of the pendulum at $\frac{1}{338}$, but a logarithmic error was subsequently discovered, which increased it to $\frac{1}{319}$. Since then the compression deduced from the measurement of more distant arcs became $\frac{1}{308}$; and that from the inequalities of the lunar motion $\frac{1}{306}$, the same author inferred an ellipticity from the pendulum of $\frac{1}{310}$, showing a most extraordinary and variable facility of agreement.

The ellipticity ($\frac{1}{288}$) given as the result of recent experiments, differs more considerably than could have been expected from $\frac{1}{306}$, which had previously been received on the authority of the most eminent mathematician of the age (Laplace) as the concurrent indication of the measurement of terrestrial degrees, of pendulum experiments, and of the lunar irregularities dependant on the oblateness of the earth. This variation in the results is occasioned by the deflection that the plumb-line undergoes, owing to the unequal density of the materials near the surface of the earth, and which affects the celestial determination of the latitudes at the extremity of the measured arcs.

Star in the Zenith.

No star has been yet observed absolutely in the zenith. This might be done under the equator, where an instrument fixed on granite, or aperture bored through a solid stratum, would reduce the problem to the simplest of all conditions.

MATHEMATICS, &c.

THE science which contemplates whatever is capable of being numbered or measured.

Nature of Mathematics.

Mathematics does not depend on the quality or existence of bodies, and the truths it teaches are naturally such. They are intrinsical truths, and wholly independent of facts or experiments. They wholly depend on reasoning, and it is impossible they should be otherwise than true, as is the case with all the properties that belong to number and figure. Two and two must inevitably and necessarily, and through all time and space be equal to four; the mind has no power of fancying how it should be otherwise.

Attraction.

. The power of attraction at double the distance is 4 times less, at triple the distance 9 times less, at quadruple the distance 16 times less, and so on, according to the squares of the distance.

The Circle.

Kepler thought that a circle was composed of an infinite number of triangles, having their common vertex in the centre of the circle, and their infinitely small bases in the circumference.

By inscribing a rectilinear figure with a curve, and circumscribing another round it, two limits are at-

tained, one greater and the other less than the area required.

If you draw a circle with a string 5 feet long, and another with a string 10 feet long, the large circle is 4 times the size of the small one, as far as the space or area enclosed is concerned; the square of 10 or 100, being 4 times the square of 5 or 25. On the other hand the length of the circumferences, that is to say, the number of feet over which the ends of the strings move, are in proportion to the lengths of the strings, so that the curve of the larger circle is only twice the length of the curve of the lesser.

The Cycloid.

A cycloid is the path which any point of a circle, moving along a plane, and round its centre, traces in the air; so that a nail on the felly of a cart wheel moves in a cycloid, as the cart goes along, and as the wheel itself both turns round its axle, and is carried along the ground.

A body moving in a cycloid by its own weight or swing, together with some other force acting upon it, will go through all distances of the same curve in exactly the same time; and, accordingly, pendulums are contrived to swing in such a manner that they shall describe cycloids, or curves very near cycloids, and thus move in equal times, whether they go through a long or a short part of the curve.

If a body is to descend from any one point to any other, not in the perpendicular, by means of some force acting on it, together with its own weight, the line in which it will go the quickest will be the cycloid, not the straight line, (though the last is the shortest of all lines that can be drawn between two points,) nor any other shaped curve whatever, although many are much flatter, and therefore shorter than the cycloid; but the cycloid, which is longer than them,

is yet of all curves or straight lines that can be drawn, the one the body will move through in the shortest time. Birds that build in high rocky precipices, drop from height to height in cycloids.

The Parabola.

When you drop a stone, or any other substance, it goes in a straight line; when you throw it forward it goes in a curve line until it reaches the ground, as may be seen when water is ejected from the pipe of a fire engine. The line it moves in is called a parabola; every point of which bears a certain fixed relation to a certain point within it, as the circle does to its centre.

Algebra.

Algebra is the expressing of quantity or the operations of quantity by conventional symbols. a, b, c, d, are the signs or characters that denote given quantities: z, y, x, &c. are the signs of unknown quantities. Equal quantities are denoted by the same character. m, n, r, s, t, are the characters of indeterminate exponents.

$+$	The sign of addition.
$-$	- - of subtraction.
$=$	- - of equality.
$:$	- - of arithmetical proportion disjunct.
$::$	- - of identity of ratio.
$\times$	- - of multiplication.
$\div$	- - of division.
	- - of involution.
$\backsim$	- - of similitude.
$\surd$	- - of radicality.

In all the applications of algebra it is not the magnitudes concerned that we consider, but merely their proportions. The letters of the alphabet, or any other symbol used in algebra, are not therefore,

strictly speaking, the representations of magnitudes; they denote ratios, or abstract numbers.

Unknown Quantities.

A quantity that is unknown is only to be found from the relations it bears to quantities that are known. By reasoning on these relations we come at last to one so simple, that the thing sought is thereby determined.

Quantities Less than Nothing.

The phrase of "quantities less than nothing" has been censured, yet there are correct ideas, which correct language can hardly be made to express.

There is a common paradox, that nothing divided by nothing, may be equal to various finite quantities.

Continued Quantity.

There are proportions of continued quantity which cannot be expressed by numbers, such as that between the diagonal and side of a square, and many others.

Asymptotes.

Right lines which approach nearer and nearer to some curve, but which, if it extended for ever, would never meet.

Logarithms.

From λογος and αριθμος—the index of the ratios of numbers to one another.

If, for example, the third term of the progression were to be multiplied by the 7th, the product must be the 10th; and if the 12th were to be divided by the 4th, the quotient must be the 8th; so that the multiplication and division of such terms is reduced to the addition and subtraction of the numbers that indicated their places in the progression.

Arithmetical and Geometrical Magnitudes.

When two points describe two different lines, the one with a constant velocity, and the other with a velocity always increasing in the ratio of the space gone over; the first of these generates magnitudes in arithmetical, the second in geometrical progression. Hence all numbers whatever would find their place among numbers so generated.

Probability.

The grounds of probability are the two following; viz.— the conformity of any thing with our own particular knowledge, experience, or observation, and the assertion of others, on whose testimony reliance can be placed.

We may call any thing improbable if the measure of the chance for its happening be less than one half ($\frac{1}{2}$).

If one premise only of an argument be probable, the conclusion is necessarily probable; but if there be two or more premises probable, the conclusion will not necessarily be probable. Supposing the probability of each premise (say *two* premises) expressed by $\frac{7}{10}$, the probability of the conclusion will be $\frac{7}{10} \times \frac{7}{10} = \frac{49}{100}$, consequently improbable, and this would increase with every additional premise. We might therefore safely bet 4 to 1 against the truth of a conclusion, founded on four probable independent premises, all singly more than $\frac{1}{2}$ in favour of it. Hence it is easy to account how it happens that the most plausible political and physical reasonings lead so often to conclusions false in fact.

Probability of Life.

For the sake of easy calculation De Moivre assumed 86 as the boundary of human life, from which having deducted the person's age (if 30 or upwards), the

half of the remainder is the average time that a man may expect to live. Thus—

	years
Boundary of human life - -	86
Suppose an individual's age to be	40
$\frac{1}{2}$	46
Average expectation of life -	Years 23

The period of life at which man (under all circumstances) has the probability of the greatest number of years to come, is the age of 33.

If the probability that one man, A, shall live a year be $\frac{6}{10}$, and the probability of the life of another man, B, for one year be $\frac{8}{10}$, the probability that both shall live another year is as 100 to 48; viz.—$\frac{6}{10} \times \frac{8}{10} = \frac{48}{100}$.

The probability of the death of A within the year being $\frac{4}{10}$, and of the death of B $\frac{2}{10}$, the probability that both shall die within the year is $\frac{4}{10} \times \frac{2}{10} = \frac{8}{100}$.

The probability that one of the events shall happen and the other fail, is, as the probability of the happening of the one, multiplied by the probability of the failure of the other. So in the above case, the probability that A shall live and B die is $\frac{6}{10} \times \frac{2}{10} = \frac{12}{100}$; and the probability that B shall live and A die is $\frac{8}{10} \times \frac{4}{10} = \frac{32}{100}$.

Chance.

Chance very little disturbs events, which in their natural constitution were designed to happen or fail according to some determined law. It may produce the *appearance* of inequality in the turning up of the head or reverse of a coin, still the appearance, one way or another, will perpetually tend to the proportion of equality. Thus in all cases it will be found, that although chance produces irregularities, still the odds will be infinitely great, that in process of time these irregularities will bear no proportion to the

recurrency of that order which naturally results from original design.

Chances on the Dice.

The probability of throwing three aces successively on one die is $\frac{1}{6} \times \frac{1}{6} \times \frac{1}{6} = \frac{1}{216}$.

Odds at Whist.

The odds for and against any particular *non* dealer's hands of trumps.—It is

12,211,799,222	to 1	that he does not hold	12 trumps.
53,326,633	to 1	- - -	11
778,068	to 1	- - -	10
25,457	to 1	- - -	9
1,567	to 1	- - -	8
163	to 1	- - -	7
26½	to 1	- - -	6
6⅕	to 1	- - -	5
7	to 4	or near 9 to 5	4
13	to 7	that he holds -	3
7⅗	to 1	or 38 to 5 -	2
57	to 1	- - -	1

It is 2 to 1 against your partner having one certain card (suppose an honour).

It is 17 to 2 against your partner having two certain cards :

But that he has one or both is about 5 to 4 in his favour.

It is 5 to 2 that your partner has one, two, or all three certain cards.

8 to 9 is about 100 to 96½ in favour of 8 with the deal: against the deal the odds are still, though small, in favour of 8.

Multiplication.

If it be required to multiply 98,765 by 25, multiply first by 100 by adding two cyphers, and then divide

by 4; the product is the same as if you had multiplied by 25, and is quicker done.

Any sum to be multiplied by 125 requires three cyphers added, and then to be divided by 8. Instead of multiplying by 5, add a cypher, and divide by 2.

In the same manner, instead of multiplying by 9, or 99, or 999, add as many cyphers to the multiplicand as there are figures in the multiplier, then subtract the multiplicand from the total. The product will be found quicker.

Multiplication may thus be easier effected by figures that are not exact dividends of whole numbers.

Ratios.

The sum of two or more ratios is obtained by multiplying the antecedents together, and the consequents together; the products will form a ratio, which is called the sum of the given ratios. Thus the ratio of 2 to 3; plus the ratio of 2 to 5; plus the ratio of 2 to 7, is equal to the ratio of 16 to 105; viz.—

$$2 \times 2 \times 4 = 16$$
$$3 \times 5 \times 7 = 105.$$

Binary Arithmetic.

Binary division in arithmetic, consisting of halves, quarters, eighths, sixteenths, &c., has always been found much more convenient and more in unison with the habits of the people, than the decimal division, which in France was found to produce great frauds, in consequence of uneducated persons being incapable of accurately distinguishing such divisions.

METAPHYSICS, &c.

ONTOLOGY; the doctrine of the general affections of substances existing.*

The objects of metaphysical speculation are the immaterial properties of an immaterial being; intangible even when concrete (not abstracted), demonstrable only as far as probability can reach, and incapable of any emblematical representation.

Stagnation of Metaphysics.

Many persons deny that metaphysics have made any progress since the time of Aristotle, although they have undergone various changes.

Voltaire compared metaphysics to a minuet, in which the parties, after all their turnings and windings, end on the spot where they began.

* This definition is taken from Dr. Johnson, but it certainly does not convey any clear idea of the term. The next explanation is from a valuable periodical work, and is scarcely more intelligible, yet it is, perhaps, as much so as the science it describes, which in modern times appears to have died a natural death, although the last, and possibly the best, of Metaphysicians (D. S.) be still alive.

Young men generally commence life with metaphysics, but when they approach thirty, usually quit them as hopeless. On the other hand, men who take to reading late in life, often get bewildered in metaphysical speculations, and are astonished at their own ingenuity and discoveries.

Precision of Expression.

We find it extremely difficult to define to others, with clearness and precision, exactly what we wish them to understand, that is to say, neither more nor less; and besides this, a man will sometimes feel himself decided by an inward sense of his own situation, which probably he would find great difficulty in explaining to the satisfaction of others. No man can exactly judge, from his own sensations, what another would feel in the same circumstances.

Ideas and Perceptions.

When the senses are employed in investigating the nature of impressions, the objects that produce them, and the circumstances by which they are modified, they are called organs of perception.

The knowledge we acquire of the relations of an impression (on the brain), is usually termed *idea*, sometimes *perception.*

Cause and Effect according to the Necessarians.

The state of things at this moment is the effect of the state of things that existed the preceding moment, and the cause of the state of things that shall exist the next moment.

Ex nihilo nihil fit.

There is nothing made from nothing. Hence, whatever exists must be eternal: whatever is eternal is infinite, since it has neither beginning nor end: whatever is infinite is singular, for if it were not, there would be several, the one serving as a boundary to the other, and of course could not be infinite.

Whatever is singular is always like itself. It follows that a being, singular, eternal, and always alike, must be immoveable, since it cannot enter a vacuum which is nothing, nor a plenum which is already full.

It ought to be immoveable, for if it experienced the least change, something comes into it which was not there before, and then the fundamental position would be destroyed—that nothing is made from nothing.—(*Anacharsis.*)

Time.

"There is, perhaps, nothing of which the mind is less capable of forming a distinct idea than time, unconnected with the notions of sensible objects; and yet, on account of this connexion, every one thinks it a subject with which he is familiarly acquainted, until an explanation be required.

The query is—Is absolute time any thing distinct from motion? But supposing the earth, planets, &c. had been without motion from the creation, still would not the duration of this state of rest have been equal to the time which has elapsed since the creation?"

Every one has his own measure of time in the quickness or slowness with which his ideas succeed each other, for time appears long to us when the ideas succeed each other rapidly in our minds, and vice versâ.

The only universal measure of time is the present instant, and yet some deny the existence of the present time, as being gone before we can note it. If there be no present there cannot be any future time, and the past certainly has no existence.

One Idea.

Time, abstracted from thoughts, actions, and motions, is actually nothing, the succession of these being what we call time. Perhaps this may account for the apparent sufferings of animals. The useful and patient horse, which to us appears to suffer from ten to twenty years of torture, perhaps, under this view of time, does not exist so many months. Sup-

posing it possible that a man, during the course of his life, could fix his mind on one idea, and keep steadily to it; to him there would be no such thing as time.

Succession.

There is a notion which we acquire by reflecting on the train of ideas constantly following one another in our minds. The distance between any parts of this succession is what we call *duration.* When this flow of ideas ceases, we have no perception of time, or of its duration, but the moment we fall into a sound sleep and that in which we awake seem connected.

The Primordium of Entity.

The Hindoos believe that all living beings originate from an atom-like germ, virtually endued with life, but inert until placed in a proper medium, when it becomes a punctum saliens or embryo. It is indivisible and indestructible, and will continue to the end of the world. When a man dies, his body restores to the earth and to the other elements, all the augmentation of substance which it had received from them; but the atom-like germ remains the same.

Existence.

Our consciousness, our memory, and every operation of the mind, are still flowing like the current of a river, or like time itself.

Every body must be imagined in *space,* and every feeling in *time.*

The Vital Principle.

Life is something that prevents the chemical decomposition to which dead animal and vegetable matter is subject, that regulates the temperature of bodies, and is the cause of the actions we observe in them.

Primary Qualities.

The instances mentioned by Locke of primary qualities, are solidity, extension, figure, motion or rest, and number.

Monades.

If there be no extended parts in nature, there can be no such thing as body, for the repetition of that which is itself unextended, can never produce any thing extended.

Death.

Arcesilaus said—Death, of all estimated evils, is the only one whose presence never incommoded any body, and which only causes concern during its absence.

Death.

It is impossible that any thing so natural, so necessary, or so universal as death, should ever have been designed by Providence as an evil to mankind.*

Death.

When the vital principle deserts the body it had constructed, and surrenders it to the laws of inorganic matter,—the last state is termed death.

Evil Spirits.

With more philosophy it might be supposed that evil cannot exist but in matter, and that an evil spirit is a contradiction in terms.

Magicians.

Nothing is so ridiculous as to condemn a *true* magician to be burned, for it must be presumed that he

* A commentator on this says—" it is generally admitted that no man can live without sin."

is able to extinguish the fire, and twist the necks of his judges.

Eyes.

The sun might shine for ever on living bodies without the smallest approach towards the producing of the sense of light; for the action of the rays of light upon the surfaces of animals has no tendency to breed eyes in their heads, or elsewhere.*

Perfectibility.

A careful distinction ought to be made between an unlimited progress, and a progress where the limit is merely undefined.

The present object of the graziers in breeding Leicestershire sheep, is to procure a breed with small heads and legs, but we must not suppose they can ever attain that degree of perfectibility as to make heads and legs evanescent quantities.

The Rule and the Exception.

It is not to be expected that the exception should become the rule, and the rule an exception.

Good and Evil.

Not being able to acquire a knowledge of the essence and qualities of things which are external to us, we are continually mistaking evil for good, and good for evil.

Fortune.

Fortune (τυχη) among the ancients seems to have denoted a principle of fortuity, whereby things come to pass without being necessitated thereto; but what

* It has been asserted that certain birds, not naturally aquatic, have, by living a long time in marshes, become web-footed.

and whence that principle is, they do not seem to have made up their minds.

Hindoo notion of Fate.

The objects of man may apparently be obtained by mortal efficacy; but that is fate: for when you speak of human qualities, you give that name to destiny. At the same time, ease is not the source of ease, nor can it be enjoyed without exertion.

Sophistry.

What is it constitutes a bald man? Being without hair. If one hair remains, is he still so? Certainly. If two, three, four, &c.?—Then one hair makes a man bald or not. In the same way one sheep will make a flock, and one grain the exact measure of a bushel.

Epimenides has said that all the Cretans are liars; but being a Cretan himself he lied; he lied when he said so. Then the Cretans are not all liars; then Epimenides has not lied; then the Cretans are liars, &c.

You have what you have not lost; you have not lost horns; therefore you have horns.

If, when you speak the truth, you say you lie, you lie; but you say you lie when you speak the truth; therefore speaking the truth you lie.

*Example of a Sorites.**

Themistocles used the following argument to prove that his little son, under ten years of age, governed the whole world.

My son governs his mother; his mother governs me; I, the Athenians; the Athenians, the Greeks;

* A *Sorites* is an accumulative syllogism, or one heaped on another.

Greece commands Europe; Europe, the whole world; —therefore my son governs the whole world.

Motion.

A body must either move where it is, or where it is not, and both suppositions are equally absurd.

Purgatory.

It has been remarked that the Popes having had the invisible world on which to fix their lever, had the *τϐ στω*, which Archimedes wanted.*

Transubstantiation.†

It is difficult to account for the zeal of the See of Rome in advancing and pertinaciously propagating so absurd a doctrine as that of transubstantiation; for what use could there be in understanding a figurative expression according to the letter when it makes nonsense, and what is worse, unprofitable nonsense?

The supremacy and infallibility of the Bishops of Rome; the doctrine of Purgatory; masses and prayers for the dead; the worship of saints and images; the celibacy of the clergy; the merit of monastic vows; the necessity of confession and absolution; the power of the Pope to grant indulgencies, and apply to the benefit of other men the works of supererogation done by saints, and consequently belonging to the treasury of the church;—all these opinions have a clear and evident tendency to raise and support the dominion and wealth of the Roman church and clergy; whereas the multiplied contradictions and impossibilities contained in the doctrine of transubstantiation served only to expose the Christian faith

* Archimedes boasted that if he had a pivot or fulcrum, on which he might rest his machinery, he could move the earth.

† That intellectual monster.

to the ridicule and contempt of Jews, Mahomedans, and other unbelievers.

It was introduced into England in the eleventh century by Lanfranc, and established by the fourth general Lateran Council under Pope Innocent III. A.D. 1215.

Liberty and Necessity.

Among the necessarian writers, Hume, Hobbes, Collins, Hutchinson, Edwards, Hartley, Priestley, and perhaps Locke, may be classed. The principal advocates for philosophical liberty are Clark, Beattie, Butler, Price, Law, Bryant, Wollaston, and Horsley.

Unitarianism.

Dr. Priestley avowed his disbelief of the doctrines of the Trinity, atonement, original sin, predestination, and eternal torments.

Insanity.

When false ideas, of a *practical* nature, are so firmly united as to be constantly and invariably mistaken for truth, we properly denominate this unnatural alliance, insanity.

To dwell constantly on one subject is a distinctive mark of insanity, for many are mad only in one single depraved imagination.

Physicians know that many are mad only in one single depraved imagination, and there are shades of aberration in the human mind which it would be impossible to define.

Mr. Simon Brown, in the 17th century, believed the extinction of his natural soul, yet, with this conviction, composed and published many learned and important works.

In Bethlem Hospital, out of 265 lunatics, only 60

had red or light brown hair; all the rest had dark hair.*

Science.

The sceptics profess to deny that we have any such thing as science; that is to say, a perception of any thing so clear and certain, and founded on such self-evident principles, as to produce absolute conviction.

* According to Mr. Locke, *folly* consists in the drawing of false conclusions from just principles, by which it is distinguished from *madness*, which draws just conclusions from false principles; but this seems too confined and technical a definition.

MORAL PHILOSOPHY.

The science of manners and of duty; the art of being virtuous and happy.

Moral Probation.

This life is not a state of unmixed happiness simply; it is not a state of designed misery; it is not a state of retribution; it is not a state of punishment:—it is a state of moral probation.

Of Evils, the least.

Setting aside all idle theories of visionary perfection, the fatal condition upon which human society exists, ever has been, universally is, and ever will be, *is the choice of the smaller evil.* So little adapted is our frail and mixed nature to the pure good, that when theorists have attempted to reduce it to practice, the fruit has been more positive evil than would have accrued from any other engine whatever. Thus in a savage, or even merely barbarous state, slavery is laudable, as it saves the captive from the axe and the faggot, and transforms the idle marauder into an industrious servant and useful member of another community.

Negative Happiness.

He that suffers the least evil is the most happy,—a position descriptive of our negative state of happiness in this world, which must be measured by the least quantity of evil, to determine the preference. We are all children of habit, and man is doomed by

his nature, in every condition, to carry a burthen equal to his strength. The changes of situation, various as they are, are only a kind of shifting of the load.

Indeed, to think himself exempt from uneasiness, is enough to give joy to a reasonable man; for the enjoyment of pleasure is not attainable, nor is it required. The absence of pain, well managed, renders our condition sufficiently happy.*

Counterfeit Happiness.

The world, in its best state, is nothing more than a large assembly of beings, combining to counterfeit happiness which they do not feel, employing every art and contrivance to embellish life, and to hide their real condition from one another.

Tranquillity.

Positive happiness being unattainable in this world, mental tranquillity is all that should be aimed at, and this can only be preserved by a strict adherence to the true spirit of the Christian religion, (founded on self-denial,) the existence of which, considering how counter its precepts run to all the base, sensual, and malignant passions of man, is in itself a daily miracle.

The Miseries of Life.

From this general and indiscriminate distribution of misery, the moralists have always derived one of their strongest arguments for a future state; for since the common events of the present life happen alike to the good or the bad, it flows from the jus-

* The word happy is merely a relative term, and when we call a man *happy*, we only mean that he is happier than some others with whom we compare him, with the generality of others, or than he himself was in some other condition. *Happiness* is an abstract idea, and in reality means nothing.

tice of the Supreme Being, that there must be another state of existence, in which a just retribution shall be made, and every man be happy or miserable, according to his works.

These miseries also afford proof of a future state, with reference as well to the mercy as justice of God. It is scarcely to be imagined that infinite benevolence would create a being capable of enjoying so much more than is here to be enjoyed, and qualified by nature to prolong pain by remembrance, and anticipate it by fear, if he were not designed for something nobler and better than a state, in which many of his faculties can serve only for his torment; in which he is to be importuned by desires that can never be satisfied, to feel evils he had no power to avoid, and to fear many which he shall never feel. There shall surely come a time when every capacity for happiness shall be filled; and none shall be wretched but by his own fault.

Artificial Misery.

The perceptions, as well as the senses, may be improved to our own disquiet, and we may, by diligent cultivation of the powers of dislike, raise, in time, an artificial fastidiousness, which shall fill the imagination with phantoms of turpitude, show us the naked skeleton of every delight, and present to us only the pains of pleasure and the deformities of beauty.

Disappointments are cruelly aggravated by our own peculiar temper and frame of mind, which see disasters only, and overshadow us with melancholy.

Temporal Blessings.

Providence permits temporal blessings to reason only.

Providence rewards nothing but good sense, which follows the simple rule of adapting means to ends.

The Moral Sense.

Different individuals possess different degrees of moral sense, as their organization and the original constitution of their minds may differ. Some persons possess an intensity of moral feeling of which others do not seem to be susceptible, and some appear to be naturally deficient in the power of taking the place of others by an act of the imagination, consequently have but little sympathy with the happiness or misery of those around them.

Sympathy.

It is an old saying, that "company in distress, makes grief less;" but to a very good-tempered man the view of human miseries would rather tend to produce sorrow than comfort, and add to his lamentations for his own misfortunes a deep compassion for the sufferings of others.

Connexion between Good Sense and Benevolence.

A comprehensive and enlightened understanding is rarely unaccompanied with benevolence of heart, and it is rare that a weak, shallow, and contracted head does not contrive to shape out for its own ends a selfish, casuistical, and pettifogging code of morality.

Individuality.

Although we may wish the prosperous circumstances of others, or to be another in his happy accidents, yet so intrinsical is every man to himself, that it may be doubted whether the apparently most miserable object would change his whole being, or become substantially another man.

Selfishness.

Selfishness and an over-anxiety about ourselves, are no doubt the cause of much misery; but we feel

as in a state of siege, acting on the defensive, occasionally invading others, and causing them to experience the same sensation. We, in fact, revolve round each other, besieging and besieged.

Care.

Happiness does not consist in an exemption from care, labour, pain, business, suspense, molestation, &c. &c., such a state not being attended with ease, but with a depression of spirits, tastelessness, imaginary anxieties, and a whole train of hypochondriacal affections.

Fashion and Ennui.

The rage among the lower classes for gaming in *lotteries, is probably encouraged by their overrating the difference between one permanent situation and another. The poor man, whose whole faculties are engaged to provide for the passing day, and whose* health is preserved by his labour, can neither see nor feel any trouble, which the possession of riches could not remove.

The two great causes of unhappiness to those raised above physical want, viz. ennui and the desire of being fashionable, are unknown to the poor; they are liable, therefore, to overrate the difference between the wealthy and themselves.

It is this intolerable vacuity of mind (*ennui*) which drives the rich and the great to the race-course and gaming table, and often engages them in contests and pursuits, the success of which bears no proportion to the solicitude and expense with which it is sought. They appear to be rather in search of *diversion* than diverted.

Maxims.

Make not your scheme of life too complicated, or such as shall require several pieces of good fortune to realize.

Expose not too great a surface to annoyance, for if you make many blots, the more certain you are of being hit.

Anticipate by your hopes the future consolation, which time infallibly brings to every mortification and affliction. Custom deadens the poignancy both of good and evil.

*Avoid all preternatural excitement, whether caused by religion, politics, or brandy, for in proportion as the imagination is excited, the understanding is weakened.

Avoid solitude and meditating on your own perfections, for they are great promoters of self importance.

In the greatest good some evil; in the greatest evil some good.

In argument suppose yourself always wrong, which in nine cases out of ten is probably no more than the truth.

Do not expect the whole of what you aim at; compromise is one of the most important elements of human intercourse.

Carefully avoid the perpetual irritation of embarrassed circumstances.

Every man may grow rich by contracting his wishes, and by quiet acquiescence in what has been given him, supply the place of more. Why fatigue destiny with complaints?

Education.

Liberal education and moral instruction are imprudently confounded, for their difference is very great. By the indiscriminate encouragement of literature, a great multitude must be inevitably exposed to disappointment for one that is benefited.*

* Knowledge is power, but it decidedly is not happiness. A modern Esculapius, steaming up from the north in the Sir Walter

Pain and Pleasure.

Two names for one feeling, which our internal agony attempts to vary in the sound, although the sensation of the last escapes our most strenuous efforts to detain it.

Man is the only animal observed to take cognizance of another's pain.*

A moderate pain, upon which the attention may fasten and spend itself, is to many a refreshment, and a moderate agitation of mind always is.

Moral Action.

Every deviation from moral action is infallibly attended by physical evils, which are destructive both of body and mind, vice having no advantage over virtue even with respect to this world's happiness.

Judging from experience, it appears probable a retribution takes place in this world as well as in the next.

Evil.

Man in the universe being only a part of a great system, fancies there is evil, but if he were permitted to survey the whole, would discover perfection where he imagined error. To this the common objection is, that what seems evil might have been avoided.

Responsibility.

The foundation of all moral feeling and conduct is a responsibility in a man's own person for the consequences of his conduct.

Scott, at the rate of ten miles per hour, is no happier than Roderic Random and Strap were in a heavy waggon. The solitary argument in favour of knowledge is a *political*, not a *moral* one; viz. that if we stagnate in knowledge while other nations advance, we must ultimately succumb, so that the least evil is to be wise and miserable.

Experience.

Experience, Dr. Franklin says, is a dear school, but fools will learn in no other.

A Lie.

A lie is a desperate cowardice; it is to fear man and brave God.

Truth.

The precept of speaking the truth will be found, when duly considered, to lead to most important consequences, as there is not only a strict connexion between truth of expression and morality of conduct; but falsehood and exaggeration virtually lessen the mental powers, and necessarily produce misconception; thus impairing the judgment, and contaminating the very source of pure morality.

The Bible.

The Bible is the sole defence of weak minds against the contagion of example.

False Religions.

To rear up or maintain a false religion, in the present state of knowledge, has become absolutely impossible.

Voltaire.

With strong perceptions of moral excellence and elevation, Voltaire was little and mean in his conduct, a victim to petty passions and caprices, never at rest either in body or mind, never tranquil, never sedate. If he was a philosopher, it was in his opinions, never in his actions. His physiognomy, partaking of the eagle and monkey, was indicative of his disposition: to the fire and rapidity of the bird, uniting the mischievous and malignant propensities of the ape.

The Imagination.

Que d'ecueil doit craindre celui qui prend son imagination pour guide. Prevenu pour la cause qu'elle lui presente, loin de la rejeter lorsque les faits lui sont contraire, il les altere pour les plier à ses hypotheses. Il mutile, si je puis ainsi dire, l'ouvrage de la nature, pour le faire resembler a celui de son imagination, sans reflechir que le temps detruit d'une main ces vaines phantoms, et de l'autre affermit les resultats du calcul et de l'experience.

It is too much to expect that mere moral speculation is to be accepted as a substitute for fact and analogical reasoning.

Passion.

When we put ourselves in the attitude that any passion naturally occasions, we soon, in some degree, acquire that passion. Hence, when persons addicted to scolding, indulge themselves in loud oaths and violent action with the arms, they increase their anger by their mode of expressing themselves; and, on the contrary, the counterfeited smile of pleasure in disagreeable company, soon brings along with it a portion of the reality.

Silence.

It is said of Socrates, that whenever he felt the passion of anger rising he became instantly silent, by which effort he not only avoided many occasions of giving offence, but actually killed the seeds of those malignant passions, which are the bane of human happiness.

Love and Hunger.

The human passions appear infinite, but may probably be all traced to two sources variously modified, love and hunger, and, perhaps, fear.

Imprisonment.

Throwing people, in certain circumstances, into prison is doing them a favour.

Fasting.

Fasting is the proper chastisement for profligacy; not any punishment that is merely attended with shame.

Wine and Sobriety.

If we consult experience, the cheapness of wine seems to be the cause, not of drunkenness, but of sobriety.

It is almost proverbial in all trades, that clever workmen are hard drinkers.

Opportunity.

Time is a never-failing friend to those who have discernment to profit by the opportunities it offers.

The lucky have whole days, and those they choose; the unlucky have but hours, and those they lose.

Cannibals.

Benevolent philosophers, who argue against the existence of cannibals, might as well deny the existence of savages; but nothing is more absurd than a wise theory of human affairs, which are neither wise nor theoretical.

Men of Business.

Some decide sagaciously enough on what ought ultimately to be done, but blunder most egregiously as to the means and method of accomplishing the object they have in view; others have not sufficient powers of mind to foresee the result of any measure, yet will immediately hit upon the means of carrying it into effect, good or bad. The last generally ruin themselves by a superfluous activity; the first dream

and stagnate. The possession of both qualities constitutes the complete man of business.

When a man has too many irons in the fire, some of them must cool.

Good Spirits.

Happiness consists in bodily health, and tranquillity, firmness and alacrity of mind; to attain which no sacrifice or abstinence, mental or corporeal, (for both, are required,) is too great. When we are in perfect health and spirits, we feel in ourselves a happiness independent of any particular outward gratification whatever, and of which we can give no account. This is an enjoyment which the Deity has annexed to existence, and probably constitutes the apparent felicity of infants and brutes, especially of the lower and sedentary orders of animals, such as oysters, periwinkles, and the like.

Object and Employment.

A man who is in earnest in his endeavours with respect to the happiness of a future state, has in this respect an advantage over all the rest of the world, having constantly before his eyes an object of interminable importance.

ELECTRICITY, &c.

Derived from the Greek word ηλεκτρον (electron), amber, in which substance the electric phenomena were first observed.

Nature of Electricity.

Different opinions are entertained among scientific men regarding the nature of electricity. By some the phenomena are supposed to depend on a single subtle fluid, in excess in the bodies said to be positively electrified; but deficient in the bodies said to be negatively electrified.

A second class suppose the effects to be produced by two different fluids, called the vitreous and resinous fluids. Others regard them as affections or motions of matter, or an exhibition of attractive powers, similar to those that produce chemical combination and decomposition; but usually exerting their action on masses.

General Properties of Electric Matter.

It penetrates bodies and traverses their substance with unequal degrees of velocity. The electric fluid always tends to spread itself over conductors, and to assume a state of equilibrium in them. It tends to escape from one body to another, but never wholly abandons even the smallest. A current of electric matter, whether luminous or not, is always accompanied with heat, the intensity of which depends on

the velocity of the current. A paratonnere will protect from lightning a circular space whose radius is twice that of the height of the conductor. Sixty feet in circumference requires a rod of fifteen feet.

Electrical attractions and repulsions disappear in vacuo, but that of currents still continues.

Ancient Electricity.

Writing concerning certain gems of a red colour, Pliny says, "Et inter has invenio differentiam; unam, quæ purpura radiat; alteram, quæ cocco; a sole excalefactas, aut digitorum adtritu, *paleas et chartarum folia ad se rapere.*"

Positive and negative Electricity,

In the early stages of this science, electricians concluded that excited glass acquired more than its natural quantity of the electric fluid by friction, and that excited wax, or sulphur, or the insulated rubber, lost part of it; called the first *positive,* and the last *negative* electricity. Berzelius divides all substances whatever into two great classes; viz. the *electro-positive* and *electro-negative.*

Vitreous and Resinous Electricity.

At present the electricity of glass is called *vitreous or positive* electricity, and that of sealing-wax *resinous or negative* electricity.

Electric Tastes.

Positive and negative electricity may be readily distinguished by the taste, on making the electric current pass to the tongue by means of a point. The taste of the positive electricity is *acid;* that of the negative electricity more caustic, or, as it were, *alkaline.*

Electric Attraction and Repulsion.

When two light substances receive the same electrical influence, or are electrified by the same body, they repel each other, but when one of them is acted on by wax and the other by glass, they attract each other. Hence it is said that bodies similarly electrified repel each other, while bodies dissimilarly electrified attract each other.

Supply and Time.

Electricity is not expended by shocks, and its effects take place in no sensible time. A discharge through a circle of four miles was found to be quite instantaneous.

Characteristic of the Gazeous Elements.

A distinguished characteristic of the gazeous elements (chlorine, oxygen, iodine, and fluorine) is—that when a compound, consisting of one of them and one of the other forty-nine more passive elements, (metals, earths, &c.) is exposed to voltaic electrization, the former is uniformly evolved at the positive or vitreo-electric pole, while the latter appears at the negative or resino-electric pole.

Chemical Affinity and Electricity.

Bodies that have chemical affinity for each other are in different states of electricity; the one being negative and the other positive. In all the changes, the acid matter collects round the positively electrified surface, and the alkaline round the negatively electrified surface.

$$\left.\begin{array}{l}\text{Acids —To the positive}\\ \text{Alkalies—To the negative}\end{array}\right\}\text{surfaces.}$$

Electricity of the Atmosphere.

On this subject the most recent speculation is, that the electricity of the atmosphere is communicated by the action of the solar rays, and it is said that M. Ampere, by a particular position of the connecting wire in the galvanic pile, has succeeded in giving to a needle, by the passing of electric currents, the direction both of dip and variation, which two phenomena are capable of being explained by electric currents passing in the atmosphere round the earth from east to west.*

Metals.

It seems to be a general law, that regarding metals as intermediate bodies, alkalies receive electricity from them, and consequently become positive; while acids communicate electricity, and consequently become negative.

M. Ampere's Theory.

M. Ampere assumes the attractive and repulsive actions of the electric currents themselves, as the primitive and fundamental fact, to which by the help of a particular hypothesis, as to the constitution of magnets, all other facts of the sciences, both of electro-magnetism and of magnetism itself, may be reduced. His supposition is that all magnetic bodies, and the globe of the earth among the number, derive their magnetic properties from currents of electricity, continually circulating among the parts of which they are composed, and having, with respect to the axes of these bodies, one uniform direction of revolution.

* The influence exerted by electricity on muscular action, (the most mysterious of all physiological problems,) is remarkable.

GALVANISM, &c.

The electricity evolved by the contact of two pieces of metal, such as copper and zinc. It has also been called animal electricity, from its effect on the animal muscle.

Perpetual Motion.

M. de Luc invented an electro-galvanic apparatus, for keeping a ball in motion, which, in 1815, had continued in motion for more than two years, and is not known yet to have ceased. The number of vibrations have varied from 45 in a minute down to scarcely one.

Copper Bottoms.

Iron nails and pins were formerly used to fasten the sheets of copper to the ships' bottoms; but since it has been ascertained that the galvanic action produced by the union of these two metals is a cause of destruction, copper nails and pins, which, although not so strong, are not attended with the same inconveniences, have been substituted.

A Galvanic Tongue.

On coating the point of the tongue with tin foil, and its middle part with gold or silver leaf, a sourish taste is produced.

Powerful Batteries.

Sir H. Davy's great voltaic battery consisted of 2000 double plates of copper and zinc, of four inches square.

Each plate of Mr. Children's large Galvanic battery consists of 32 square inches, and produces intense heat. Iron was instantaneously converted by it to blister steel, and diamond powder disappeared.

Copper and Sea Water.

The chemical action of bodies on each other may be modified or destroyed by changing their electric states. By bringing a body, naturally positive, artificially into a negative electric state, its usual powers of combination will be destroyed. It was upon this principle that Sir H. Davy applied a negative power to prevent the corrosion of the copper sheathing of ships.

Copper, being a metal only weakly positive, could be easily rendered slightly negative, when all its chemical action on the sea water would cease, and it was subsequently found that a piece of zinc no larger than a pea or the point of a small iron nail, by effecting this change, preserved from 40 to 50 inches of copper, exposed for many weeks to the full flow of the tide in Portsmouth harbour, while the zinc or iron was slowly corroded.

Copper sheathing, until it is worn into holes, corrodes so fast that no permanent surface remains to which weeds can adhere, but when there are inequalities on the surface, they adhere readily enough even to the poisonous oxide of copper. It is probable that protectors, if made a little positive, or nearly in equilibrio, will preserve the whole surface smooth, and prevent the adhesion of either shell fish or weeds. At present the requisite proportion is estimated to

lie between $\frac{1}{120}$ and $\frac{1}{240}$, but that even $\frac{1}{300}$ would save half the copper of the British navy.

Weak solutions of salt were found to act strongly on copper, but strong ones did not affect it.*

* Although the experiments of Sir H. Davy have proved the power of iron to prevent the oxidation of copper, it has failed to cure the greater evil, the accumulation of weeds and shells on the bottom, to provide against which copper was first introduced. The government, it is said, have discontinued the practice of applying iron protectors.

MAGNETISM, &c.

THE power of the magnet. It is one of the imponderable substances, and does not affect irritability, sensibility, or influence chemical action.*

The Magnet.

Aaron Hill says the ancient Greeks called the loadstone λιθος Ηρακλεια; the later Greeks Μαγνητις λιθος; and that the latter term was properly applied to a species of lapis ollaris or potstone.

The Magnetic Needle.

If we hang up a magnet by a thread, or allow it to swim in quicksilver or place it on a small bit of wood floating in water, it never comes to a state of rest until one end points to the north, and the other to the south. The needle or index of a compass is a prismatic piece of tempered steel, which by having been rubbed on a magnet has acquired the magnetic power, and which being placed on a pivot is at liberty to turn in all directions.

Degree of Attraction.

Iron is the only substance principally attracted by the magnet. The degree of magnetic attraction depends on the strength of the magnet itself, the weight and shape of the iron presented to it, the magnetic or

* From recent experiments the last appears doubtful.

unmagnetic state of the body, and the distance between them.

Magnetic Action.

The system of magnetic emanations, by which the phenomena of the action of magnets at a distance was formerly explained, has long been deservedly exploded, and magnetic action has been resolved into the more general and more simple fact of attraction and repulsion, between the particles of all matter, according to a certain function of their distance.

The magnetic agencies are referrible to one of two contrary polarities, the northern and the southern.

Sir Isaac Newton's Magnet.

The smallest natural magnets generally possess the greatest proportion of attractive power. The magnet worn by Sir Isaac Newton, in his ring, weighed only three grains, yet it was able to take up 746 grains, or nearly 250 times its own weight; whereas magnets weighing above two pounds, seldom lift more than five or six times their own weight.

Iron.

One magnet attracts another with less force than it does a piece of iron; but the attraction begins at a greater distance. The power of a magnet is weakened by heat.

Magnetic Attraction and Repulsion.

Magnetic attraction only takes place betwixt the opposite poles of two magnets. When either the north or south poles of two magnets are placed near each other, they repel; but a north and south pole attract each other.

That magnetic attractions and repulsions follow the law of the square of the distance has been regarded

as nearly demonstrated by the experiments of Coulomb, Lambert and Robinson.

*Dip of the Needle.**

A magnet placed in such a situation as to be entirely at liberty, inclines one of its poles to the meridian, and of course elevates the other;—this is called the dipping of the magnet. In London it dips ; at the north-west magnetic pole it would stand nearly in a perpendicular direction.

At Port Bowen the dip is 88°.—Lat. 73° 14′ N. Long. 88° 54′ W.

Iron Railings and Carriage-Wheels.

All iron bars standing erect or fixed perpendicularly (such as the iron railings before houses) are magnetic, the north pole being at the bottom, and the south at the top.

It is also a curious fact, that the uppermost part of the iron ring round a carriage-wheel, attracts the north end of the magnet, and is consequently a south pole, while the lower part of the same iron, in contact with the ground, attracts the south end of the needle, and is therefore a north pole. Turn the same wheel round half a circle, and these poles immediately become reversed.

Cannon Boring.

The cutters in gun boring become magnetic in consequence of being continually rubbed in the same direction.

* The Variation of the Compass was first discovered by Sebastian Cabot, a Venetian, about A.D. 1500, and the variation of that Variation by Mr. Gillebrand, an Englishman, A.D. 1625.

The dip or inclination of the needle to a point beneath the horizon, when allowed to play vertically, was first discovered by Mr. R. Norman, about A.D. 1576. The diurnal variation of the needle was discovered by George Graham in 1725.

The Magnetic Power on the Surface.

It has been discovered that the power of magnetic attraction resides wholly in the surface of the iron bodies, and is independent of the mass. An empty bomb-shell will attract as strongly as a solid sphere of the same material.

Wedgewood's Black Ware.

Wedgewood's black ware, which is made of basalt, attracts the magnet strongly.

*Electricity and Magnetism.**

Electricity affects all bodies, whether as passing through them, or as being attached to their particles; on the contrary there are only a small number of bodies, such as iron, steel, nickel and cobalt,† in which distinct traces of magnetic action have been observed. Hence it has become a question whether magnetism be a peculiar fluid, found only in bodies susceptible of its influence; or, if it be merely a modification of the electric fluid, distributed in a particular manner. All that has hitherto been proved is, that magnetism may be developed in different bodies by the action of electricity, but the identity of the fluids has not yet been proved, although the experiments of Mr. Oersted has gone very far towards establishing this fact.

What has hitherto been considered as the magnet-

* The controversy relative to the two hypotheses on which electrical phenomena are explained, seems almost equally balanced, the scale rather inclining as yet to those who maintain the existence of electricity and magnetism as two distinct fluids.

† Since the above was written the experiments of M. Arago and Mr. Barlow extend this property, of being affected by the magnet under certain modifications, to all metallic substances, and various other bodies, proved capable of receiving magnetic impressions, though in a more evanescent manner than malleable iron, and in an infinitely less intense degree.

ism of the earth may be only modified electricity; and it is probable that hereafter all the magnetic phenomena will be considered the effect of electric currents.

Chinese Poles.

In China the south pole alone is considered the attracting power.

Aurora Borealis.

This meteor is strongest and most frequent about the Arctic circle, or between that and the parallel of 64° N. At Melville Island, which is about lat. 75°, the coruscations are much fainter in comparison. The observations of Capt. Franklin's party appear to have determined, that the height of the aurora is rarely above six or seven miles. It frequently darts below the clouds, and at very short distances from the earth's surface, and is even acted on by the winds. That it makes a rustling noise is asserted by all the North-west traders, but this sound was not heard by any of the officers of the two expeditions. A brilliant aurora, when it approached the zenith, drew the magnetic needle about a degree out of its usual direction, which it did not regain for five or six hours. Where Capt. Parry wintered, it ought to have been called the *Aurora Australis*, as it always appeared in the southern horizon.

VARIATION OF THE COMPASS.

The deviation of the magnetic needle from its parallel with the meridian, or east or west from the true north and south points.

Progressive Motion of the Variation.

In 1576, about the time when this phenomenon was first remarked, the variation was found to be 11° 15′ E., consequently at that time a ship to sail due north, found it necessary to steer north by west.

Although the variation of the compass when first discovered was only 11° 15′ E., there can be little doubt that about A.D. 2010, it will again be as much east as it is now west. In A. D. 1662 the variation in London was nothing.

Discovery of the Variation of the Compass.

The first discovery of the variation of the compass is by some ascribed to Columbus, by others to Sebastian Cabot. That it was discovered so late in Europe and not at all in China, where the compass had been longer known, may be accounted for from this circumstance, that in Europe it was then very small, and in China for these two or three hundred years, in some places nothing, and no where more than two degrees.

Retrogradation of the Variation.

In the rooms of the Royal Society the mean variation in June, 1817, was 24° 17′ 54″ West.

In June, 1818,	- -	24	17	0
In June, 1819,	- -	24	15	43

From which it would appear that it had already begun to return from its extreme western deviation.

Greatest Variations.

The coasts on which the greatest deviations of the needle have (until recently) been observed, are, Cape Farewell, Davis's Straits, Hudson's Bay, and Baffin's Bay. Between Cape Farewell and Labrador it is 42° and 50°; whereas in East Greenland, which is at no very great distance, the variation does not much exceed one point (11° 15′), and to the east of the island entirely ceases.

Daily Horizontal Variation.

The daily horizontal variation of the needle in England ranges from about six or seven minutes of a degree to fifteen minutes; the first being the quantity due to the winter months; the last to the summer months. The quantity is so inconsiderable that without great care it cannot be observed. During Captain Parry's expedition in 1825, the daily variation amounted to as many as six and seven degrees. The needle was in a state of perplexing vibration, yet still following a certain order in its motion, which increased as the sun approached the summer solstice.

Extent of the Variation.

In the northern hemisphere the western variation extends over a space of 244° 44′, and in the southern hemisphere, in the same parallel of latitude, 143° 10′; the balance of each circle being the utmost extent of the easterly variation.

Diurnal Variation.

The diurnal variation, both in the direction of the needle, and in the magnetic intensity, appears to have reference to the position of the sun with regard to

the magnetic meridian; it is therefore probable that the sun is the principal cause of both phenomena. The circumstance of the situation of the magnetic pole, in what appears to be (independent of elevation) the coldest region of the globe, supported by the fact of a diminished temperature causing an increase of magnetic intensity, would lead us to infer that the effect produced by the sun is principally to be attributed to the heat developed by it. But should any periodical effects, corresponding to the time of the sun's rotation round its axis, be observable in the diurnal variation, we must suppose that the sun like the earth, is endued with magnetism, and look for a cause of this magnetism common to all the planets.

The Magnetic Equator.

The magnetic equator crosses the terrestrial four times; viz.—in 25° East, and in 108°, 125°, and 170° West. The eastern and western lines of no variation are traced in a chart in one of the early numbers of Dr. Brewster's Journal.

The North-west Magnetic Pole.

Among the Georgian Isles on the north coast of America, a balanced needle became so weak and sluggish as to be nearly annihilated; that is to say,

The magnetic action of the real north pole of the earth became as nothing compared with the strong and direct attraction of the north-west magnetic pole, evidently situated within the earth, whether as a line, area, or point, is uncertain. If the latter, it may be supposed to reside about lat. 70° N., long. 90° W. from Greenwich, in which locality the observations of Capts. Ross, Parry, Franklin, and Lyon, all agree. If Capt. Parry had been able to proceed from Cape Hallowell to the west, he would have sailed across the magnetic pole.

Are two magnetic poles sufficient to explain all the phenomena of the variation of the compass, or are we under the necessity of assuming more? Formerly Professor Hansteen placed a north-east magnetic pole in lat. 85° 49′ North, long. 101° 30′ East.

Movement of the Magnetic Pole.

The magnetic pole does not move under a parallel of latitude; it does not move in a curve or straight line under a meridian; it does not move in any line on any side of the pole of the earth; and consequent its movement must be in some unknown and very eccentric curve round the pole of the earth.

No satisfactory theory of the variation of the compass can be established, but on the supposition that the earth is not solid.

In the most elevated regions of the earth's atmosphere hitherto attained by man, the magnetic needle remains as strongly polarized as at the surface of the earth.

It was obvious in Captain Parry's third voyage, that since 1819, the magnetic pole had moved considerably to the east.

Professor Hansteen's Theory supposes a motion eastward of eleven minutes (11′) every year.

Neutralization of the Attraction of the Ship's Iron. *

Place the centre of a small circular iron plate in the line of no attraction (of the ship's iron), and at a proper distance *behind* and *below* the pivot of the compass needle, (which must be ascertained and fixed before the ship leaves port,) and the needle will not only remain active and vigorous in the polar regions, but will continue to point to the correct magnetic meridian, uninfluenced by the attraction of the ship's iron in every part of the world.

* Usually called *Deviation.*

State of the Variation in 1825.

Over the whole of Europe, the variation of the compass was then westerly; viz.

Petersburg, 8° West.
Stockholm, $15\frac{1}{2}$° do.
Christiana, 20° do.
London, 24° do.
Iceland, (north coast,) 40° West.
Greenland, at Good Hope Colony, 51° West.
Prince of Wales Fort, Hudson's Bay, 10° West, further on it vanishes, and at last becomes easterly.
Nootka Sound, 20° East.
Behring Straits, $35\frac{1}{2}$° East.

The magnetic declination of the needle at Paris in 1822 was 22° 11′ West, in 1823, 22° 23′ West.

PNEUMATICS, &c.

A BRANCH of mechanics which considers the doctrine of air, or the laws according to which that fluid is condensed, rarefied, or gravitates.

Atmosphere.

The air that encompasses the solid earth on all sides.

Its constituent parts.

Mr. Cavendish ascertained that there is no sensible difference in the constituent parts of the atmosphere, under circumstances the most dissimilar. The air of London, with its half million of blazing fires, equals in purity the freshest breezes of the country; nor could any difference be discovered between the chemical composition of the air of a crowded room in a fever hospital, and the common open atmospheric air.

It has also been found to be extremely uniform in all parts of the world, and at all heights above its surface; consisting invariably of

	By measure.	By weight.
Oxygen - - -	21 parts	23 parts.
Nitrogen or Azote	79	77
	100 parts.	100 parts.

Extraneous Ingredients.

Although the above are the essential component

parts of atmospheric air, it contains other substances, which may be regarded as adventitious, and liable to vary in quantity. Of these carbonic acid and aqueous vapours are the most important and constant. The quantity of the first may be usually considered as less than one per cent.

Height of the Atmosphere.

One hundred cubic inches of air, at the level of the sea, when the thermometer is at 60°, weigh 30½ grains. The whole atmosphere is equal in weight to a sheet of mercury, 30 inches, or to a sheet of water, 34 feet deep, and were its density every where the same, would reach no higher than 27,000 feet or five miles. But its extreme elasticity causes the upper strata to expand indefinitely, and the phenomena of meteors show that it exists in a state of extreme attenuation at a height a hundred times greater than this.

The density of the air is reduced one half by an ascent of about 18000 feet. while that of vapour undergoes the same degree of attenuation at the height of about 4,500 feet.

Meteors.

Whatever is the nature of meteors, it is incontestable that they, as well as what are called falling stars, come from beyond the atmosphere, and that they inflame on penetrating it. Their rapidity necessarily proves great projectile force.

Atmospheric Changes.

There can be no doubt that the series of atmospheric changes, however apparently complicated and perplexing, are as regular and determinate in their natures as tides of the ocean, or the revolutions of the celestial bodies.

Phenomena of the Winds.

The phenomena of the winds, however various, are supposed to result from two general movements: that of the cold air from the pole towards the torrid zone, and of an upper and contrary current from the equator towards the pole. The line of division between the upper and lower currents should be where the mercury stands at 15 inches, which is at the height of $3\frac{1}{2}$ miles. This ought to be the boundary of the region of the clouds, which indeed are sometimes seen to approach this elevation.

In Great Britain, on an average of ten years, westerly winds exceed the easterly in the proportion of 225 to 140 days.

Effects of the Winds.

The different ingredients of the atmosphere are mixed together by high winds, which, when they are strong, move at the rate of from 60 to 100 miles per hour. In our winter the south-west winds convey the air that has been purified by the vast forests and savannahs of South America, and which, passing over the ocean, arrives uncontaminated.

Atmospheric Pressure.

The ordinary pressure of the atmosphere, at the surface of the earth, is equal to 15 pounds on the square inch of surface. Ten atmospheres therefore are 150 pounds, twenty, 300 pounds, and so on.

Variation of the Atmospheric Pressure.

The annual range of the barometer, which indicates the variation of the pressure, does not exceed $\frac{1}{8}$th to $\frac{1}{2}$ inch in the torrid zone; is about 2 inches at Liverpool and St. Petersburgh, and $1\frac{8}{10}$ inches at Melville Island. The extreme variation, which no where ex-

ceeds $3\frac{1}{2}$ inches, is not greater than one ninth part of the total pressure, which is 30 inches of mercury.

Specific Gravity.

One hundred cubic inches of atmospheric air weigh $30\frac{1}{2}$ grains.

The specific gravity of atmospheric air being considered as 1, it is about 828 times lighter than the same bulk of water; but with respect to steam it is as 1 to 0,6235.

Evaporation and Temperature.

The reduction of temperature by the evaporation of moisture is obviously a measure of the hygrometric state of the atmosphere, for if the air be saturated with moisture, it produces no evaporation.

A Vacuum.

Whether there be any such thing in nature as an absolute vacuum; or whether the universe be completely full, and be an absolute plenum, are points that have been controverted by philosophers in all ages.

That the motion of the planets and comets may be regular and permanent, it appears necessary that the celestial spaces be devoid of all matter, except the passing rays of light.

The quantity of matter in any given space may be diminished by rarefaction, and why not ad infinitum? The solid ultimate particles of body have all the same density, being incapable of further condensation, and are only rarefiable by means of their pores.

Sir Isaac Newton observed that a thermometer suspended in vacuo, and in that state removed to a warm or cold room, receives the heat or cold, rises or falls, almost as soon as another in the open air. By what medium is the heat or cold conveyed?

Barometer.

A machine for measuring the weight and variations of the atmosphere.

Barometric Changes.

The mercury in the barometer is seldom to be seen lower than 28 inches, or higher than 30½. It indicates as follows:

31 inches	-	Very dry weather—hard frost.
30½	- - -	Settled fair—settled frost.
30	- - -	Fair—frost.
29½	- - -	Changeable.
29	- - -	Rain—snow.
28½	- - -	Much rain—much snow.
28	- - -	Stormy weather.

In January, 1822, the mercury fell to 28°10, which is said to have been the lowest ever remarked in England. By the fall, a pressure equal to 2000 lbs. was removed from each person's body, yet probably no individual was at the time conscious of it. The maximum height of the mercurial column is about nine o'clock A.M.; the mean at twelve, and the minimum at three P.M. If the column rise from nine A.M. to three P.M. it indicates fine weather; if it fall during that interval, rain may be expected.

The Wheel Barometer of the form of a Syphon.

A small float of iron or glass rests on the exterior surface of the mercury, suspended by a slender thread, passed round a small wheel or cylindrical axis that carries the index. By this construction the variation of the height of the mercurial column is reduced to half the ordinary measure, yet the circumference traversed by the needle is greatly augmented.

The Common Barometer.

A tube, a quarter of an inch in diameter, is a good

width for a barometer. If the tube be perfectly clean, pure mercury has always a convex surface ; if soiled or stained, the mercury will become flat or concave.*

Natural Condition of the Barometer.

The fall of the barometer is connected, not with the existence of clouds or fall of rain, but with their formation, for it may fall while clouds are forming, and rise when this process has ceased although rain fall.

The state in which the barometer continues longest without change, may be considered its natural condition, and it is for much longer periods high than low. An approach to its highest elevation therefore may be considered its natural condition.

Mensuration of Heights.

At the surface of the earth the mean density or pressure is considered equal to the support of a column of mercury - - - 30 inch. high.

At 1000 feet	above the surface the column falls to - -	28·91
2000 -	- ditto - -	27·86
3000 -	- ditto - -	26·85
4000 -	- ditto - -	25·87
5000 -	- ditto - -	24·93
1 mile	- ditto - -	24·67
2 -	- ditto - -	20·29
3 -	- ditto - -	16·68
4 -	- ditto - -	13·72
5 -	- ditto - -	11·28
10 -	- ditto - -	4·24
15 -	- ditto - -	1·60
20 -	- ditto - -	0·95

* Mr. Daniel says, the common instruments are mere play things, scarcely two agreeing within a quarter of an inch, whereas the questions of meteorology, now of interest, require the measurement of $\frac{1}{100}$th part of an inch of the mercurial column.

The barometer constantly descends in a geometrical ratio for equal ascents in the atmosphere, subject to a correction for the decreasing temperature of the elevation.

Mensuration of Heights by the Boiling Point.

In consequence of the diminution of the atmospheric pressure as we ascend, fluids evaporate at a much lower degree of heat. Near the top of Montblanc, water boiled at 187°, instead of 212°, the boiling point at the level of the sea.*

Cloudless Elevations.

Owing to its rarefaction, the air beyond a certain height is incapable of sustaining clouds. The principal masses of clouds are sustained in the air at a height between 4500 and 7500 feet, the average being rather more than a mile.

Origin of Rain.

Rain is produced by the mixture of atmospheric currents of different temperatures. The power of the air to hold water in solution does not increase in the same ratio with the increase of its temperature, but in a much higher ratio. Hence, when two masses of air, saturated with moisture and of different temperatures, are mixed, the resulting compound is not capable of holding the whole water in solution, and a part is in consequence precipitated as rain. As the whole atmosphere (which is a vast laboratory in perpetual action) when saturated, is calculated not to hold in solution more water than would form a sheet five inches in depth, while the mean annual deposit

* With a tea-kettle and thermometer, a tolerable approximation to the true height of the highest mountain may be attained; but great care must be taken to keep the water free from all extraneous matter, the presence of which Dr. Bostock thinks affects the boiling point 4·5 degrees.

of rain and dew is probably from 35 to 40 inches, it is obvious that the supply of atmospheric moisture must be renewed many times in the course of a year.

Rain.

Nature has so arranged it, that the supply of the atmospheric moisture is most abundant in the latitudes where the evaporation is most rapid; or rather the processes of evaporation, depending partly on the same principles and exerting a reciprocal influence, tend to adjust themselves to each other, although this tendency is perpetually disturbed by local causes.*

The result of experiment has shown that a greater amount of rain falls while the sun is below, than while it is above the horizon.

Rain.

The mean quantity of rain is greatest at the equator, and decreases as the poles are approached.

			Inches.
At Grenada, in	12° N. lat.	it is per annum	126
Cape Français	19·46	ditto	120
Calcutta	22·23	ditto	81
Rome	41·54	ditto	39
England	53°	ditto	32
Petersburgh	59·16	ditto	16

Rain at Oxford.

The mean quantity of rain that fell at Oxford,

* At Lima, (lat. 12° S. long. 76° W.) situated 580 feet above the level of the sea, within 5 miles of the Pacific, and 20 leagues of the great chain of the Andes, up to A. D. 1821, no rain had fallen for 14 years.

taking the average of six years, was only 21·781 inches: viz.

1816,	24 inches.	1819,	21 inches.
17,	19 inches.	20,	17 inches.
18,	23 inches.	21,	25 inches.

In 1821, the average quantity that fell at Tottenham was 33·84 inches. Mr. Dalton reckons the annual deposit of water in England at 31 inches of rain and 5 inches of dew.

Rain in the Torrid Zone.

The following estimate by Humboldt is given as an approximation to the depth of rain that falls in different parallels:

	Inches, English.		Inches, English.
Lat. 0° -	96	Lat. 45° -	29
19° -	80	60° -	17

Although the annual depth of rain is greatest within the torrid zone, the number of rainy days follows an inverse order, and diminishes as we advance from high latitudes to the torrid zone. But even within the torrid zone there are tracts where rain seldom or never falls, such as the Sahara desert of Africa, the low coasts of the Caraccas, and the desert shore of Peru, between 15° and 30° south latitude.

Total Weight of the Annual Rain.

Taking the specific gravity of mercury to be to that of water as 14 to 1,—if we suppose the whole quantity of rain that falls in a year (say 28 inches) to be dissolved and suspended in the air at one time, it would only support two additional inches of mercury, and on the supposed fall of the whole quantity the mercury would only sink two inches.

Dr. Hutton's Theory is,

That as the power of the air to imbibe moisture increases in a higher ratio than the temperature, two

portions of air of different temperatures, and saturated, or nearly so, with moisture, cannot be intermingled without its precipitation. This precipitation in its turn is a fresh cause of wind, of the collision of different airs, and of the renewed formation of clouds and rain; and the contraction that thus takes place in the atmosphere diminishes its elasticity, lowers the barometer, and again becomes a cause of wind.

Evaporation.

The evaporation of water is about equal to the fall of rain. In ordinary soils 30 inches out of 38 escape by evaporation. In the case of large rivers flowing over extensive and level surfaces, the water carried to the sea does not exceed one fifth of what falls in rain, snow, and dew.

Rainbows.

Rainbows are only visible when the altitude of the sun is between 45° and 56°. In summer, therefore, in this latitude, they are not seen about the middle of the day. A dense halo round the moon portends rain.

Effect of Mountains on the Atmosphere.

Mountains precipitate the moisture of the atmosphere, not so much by attracting it to their summits as in consequence of their rocky and grassy sides, when acted on by the sun, heating large masses of air in the cold upper regions of the atmosphere, which streaming upwards, come in contact with cold currents moving laterally, or otherwise generate circumstances that will cause precipitation.

A small increase of elevation compensates, in adding to the quantity of rain, for a great distance from the sea. At Geneva the annual fall of rain is 40 inches, while at Paris (300 miles nearer the sea) it is only 19½ inches.

In England it is found that Keswick and Kendall, situated among the mountains, have 67 and 69 inches of rain annually, while places in the level country and on the sea-coast have only 24 inches. But although more rain falls in mountainous than in level countries, the depth is greater at the bottom than at the top of a mountain, and close to the surface of the ground than at a distance from it.

Garnerin's Balloon.

The hydrogen gas of Garnerin's balloon weighed 44 pounds, which being 13 times lighter than atmospheric air, would of course float - 572 pounds.

Suppose the balloon altogether to weigh -	112 pounds	
Add for the passengers, &c.	400	512
Weight remaining to work upon		60 pounds.

Coal Gas Balloons.

Mr. Green has the merit of being the first person who tried experiments on the buoyant properties of coal gas. In some of his preliminary trials he ascertained that the ascensive force of a small balloon, three feet in diameter, was equal to eleven ounces; and when filled in the old way, with hydrogen gas, not more than fifteen ounces.

Greatest Elevation attained.

Gay Lussac, in a balloon, reached the height of 23,040 feet, or 4 miles 1920 feet.

Colour of the Sky.

Although the sky is known to have a blue colour, the air itself is altogether colourless and invisible. The blue colour is occasioned by the vapours in the

air reflecting the blue rays more copiously than any other. The higher the observer is placed, the deeper the blue becomes; consequently, at a certain height, the blue will disappear altogether, and the sky become black; that is to say, will reflect no light at all. The colour becomes always lighter in proportion to the quantity of vapour mixed in the air; hence it is obviously caused by the vapour.

Another Explanation.

The colour of the sky depends on the quantity of opaque vapour in the air. The less vapour there is, the darker is the colour of the sky. If the air were entirely free from opaque vapour the sky would appear black. The particles of opaque vapour in the sky reflect chiefly the blue rays, and thus give rise to the blue colour of the sky. The colour of the sky is darker at the zenith than at the horizon, because the quantity of vapour through which the eye looks at the horizon is greater than at the zenith.

MECHANICS.

DR. WALLIS defines mechanics to be the geometry of motion.

Subdivisions of Mechanics.

Mechanics, in its most extensive meaning, is the science which treats of quantity, of extension, and of motion. That branch which considers the state of solids at rest, such as their equilibrium, their weight and their pressure, &c. is called *Statics;* and that which treats of their motions, *Dynamics*. When fluids are considered instead of solids, that branch which treats of their equilibrium, &c. is called *Hydrostatics;* and that which treats of their motion, *Hydrodynamics*.

By Sir Isaac Newton this science is divided into practical and rational mechanics; the first relating to the mechanical powers; (viz. the lever, balance, wheel and axis, pulley, wedge, screw, and inclined plane;) the latter (or rational mechanics) to the theory of motion; showing, when the forces or powers are given, how to determine the motion that results from them; or conversely, when the circumstances of the motion are given, how to trace the forces or powers from which they arise.

Quantities.

The five mechanic quantities are—

1. The quantity of matter moved.
2. The constant force that moves it.
3. The space described from rest.
4. The time of description.
5. The velocity acquired.

Statics.

In 1592, Galileo composed a treatise on statics, which he reduced to this simple principle; viz. It requires an equal power to raise two different bodies to heights having the inverse ratio of their weights; that is, whatever power will raise a body of two pounds to the height of one foot, will raise a body of one pound to the height of two feet.

The Vis Inertiæ of Nature.

One of the grand laws of nature is, that all bodies persevere in their present state, whether of motion or rest, unless disturbed by some foreign power. Motion, therefore, once begun, would be continued for ever, were it to meet with no interruption from external causes, such as the power of gravity, the resistance of the medium, &c.

The Lever.

If the lever be 17 feet long, and the pivot or fulcrum be a foot from one end, an ounce placed on the other end will balance a pound placed on the near end. If, instead of an ounce, we place upon the long end the short end of a second beam or lever, supported by a fulcrum one foot from it, and then place the long end of this second lever upon the short end of a third lever, whose fulcrum is one foot from it; and if we put upon the end of this third lever's long arm an ounce weight, that ounce will move upwards a pound on the second lever's long arm, and this moving upwards will cause the short end to force downwards 16 pounds at the long end of the first lever, which will make the short end of the first lever move upwards, although 256 lbs. be laid on it. The same effect continuing, a pound on the long end of the third lever, will move up a ton and three quarters at the short end of the first lever, so that the

touch of a child's finger will move as much as two horses can draw.

The lever in mechanics compensates power by space, and what is lost in power is gained in time. In engines that act by the mere force of gravity, what we gain in power we lose in velocity, and the reverse.

The Wheel and Axle.

This is only a lever moving round an axis, and always retaining the effect gained during every part of the motion, by means of a rope wound round the but end of the axle; the spoke of the wheel being the long arm of the lever, and half the diameter of the axle the short arm. By a combination of levers, wheels, and pullies a great increase of force is obtained.

Percussion on one Point.

If an ivory ball strike against another of the same weight, there should, according to common theory, be an equal transfer of motion. But if the velocity of the impinging ball be very considerable, so far from stopping suddenly, it will recoil back again with the same force, while the ball which is struck will remain at rest.

The reason of this is, that the shock is so momentary, as not to permit the communication of impulse to the whole mass of the second ball. A small spot only is affected, and the consequence is therefore the same as if the ball had impinged against an immoveable wall.

It is on a similar principle, that a bullet, fired against a door hanging freely on its hinges, will perforate the same, without in the least agitating it. Nay, a pellet of clay, a bit of tallow, or even a small bag of water, discharged from a pistol, will produce the same effect.

In all these instances the impression of the stroke

is confined to one single spot, and no sufficient time is allowed for diffusing its action over the extent of the door.

The Rota Aristotelica, or Aristotle's Wheel.

The outer circle of a wheel, while making a revolution along a plane, describes thereon a right line equal to its circumference.

Now if this circle (called the deferent) carry along with it another small circle concentric with it, having no motion but what it receives from the deferent, (like the nave of a coach-wheel carried along by the wheel); this circle or nave, will, during the revolution, describe a line equal, not to its own circumference, but to that of the wheel, because its centre advances in a right line as fast as that of the wheel does.

The matter of fact is certain, but how it should be seems a mystery. It has been attributed to the sliding of the nave along the right line described by the outer circle.

The Descent of Bodies.

A body falls by gravity precisely $16\frac{1}{16}$ feet in a second, and the velocity increases according to the squares of the time: viz.

In ¼″ (quarter of a second) a body falls				1 foot.
½″ (half a second)	-	ditto	-	4
1 second	- -	ditto	-	16
2 ditto	- - -	ditto	-	64
3 ditto	- - -	ditto	-	144

The power of gravity at two miles distance from the earth is four times less than at one mile; at three miles, nine times less, and so on. It goes on lessening, but is never destroyed.

Force.

The force of any body striking against an obstacle, is directly in proportion to its quantity of matter, multiplied by its velocity.

Velocity.

The velocity of a musket ball is on an average 1600 feet per second, and its range half a mile; whereas by theory its range ought to be ten miles. The resistance of the air is the cause of its retardation.

In velocities exceeding 1600 feet per second, the resistance of the air is greatly increased; hence the absurdity of giving balls too great an initial velocity. To give a bullet the velocity of 2000 feet per second requires half as much more powder as to give it the velocity of 1600 feet, yet after both have moved 400 feet, the difference between the velocity of each is reduced to eight feet per second.

A 24 pound ball, moving at the rate of 2000 feet per second, meets a resistance of 800 pounds. As the ball is diminished in size, the resistance is also diminished, but only in proportion to the squares of the diameter, whereas the momentum is diminished in the ratio of the cube of the diameter.

If a body could be projected upwards with the velocity of 36,700 feet in a second, it would never return, and as it receded from the earth its weight or gravity would diminish. At present the greatest velocity with which we can project a body, does not exceed 2000 feet per second. A bullet, rising a mile above the surface of the earth, loses $\frac{1}{2000}$th part of its weight.

The Solid of least resistance.

A solid globe, of all figures, occupies the least space; on moving through air or water a long thin sharp pointed rod receives the least possible resist-

ance; but the solid of least resistance has a curve resembling closely the head of a fish.

Light and Sound.

Light moves at the rate of 170,000 miles per second.

The mean motion of sound through the air is equal to 1142 feet per second.

From Pole to Pole.

An impression might be transmitted through the ocean from pole to pole in the space of two hours and fifty-five minutes. Hence probably originates the intumescence of the sea which commonly precedes a storm: for supposing a storm to arise at the distance of 50 degrees of latitude, it would not reach a certain spot in less than thirty hours, whereas the agitation of the waters would begin to be felt in $48\frac{2}{3}$ minutes.

Gunpowder.

English powder consists of	nitre 75,	sulphur 10,	charcoal 15=100
Beaume's ditto	80,	5,	15=100

The explosive power of gunpowder depends on the quantity of gas permanently generated, which gas is almost entirely produced by the combustion of the charcoal, the nitre being only the cause of that combustion by converting the charcoal into carbonic acid. The two other elements are the heat and the rapidity of the inflammation, which last is secured by multiplying as much as possible the intervals for the passage of the flame, or by diminishing the size of the grains.

The permanently elastic fluid, generated in the firing of gunpowder, is calculated by Mr. Robins to be about 244 times the bulk of the powder, and that the heat generated at the time of the explosion,

occasions the rarefied air thus produced to expand about 1000 times the space of the gunpowder.*

Range of Shot, Rockets, and Bombs.

The range of Congreve's rockets is 3,300 yards, or nearly two miles.

The large mortar in the park is said to have thrown a 13-inch bomb-shell, filled with lead, above three miles.

The mean vertical ascent of a great number of common rockets, discharged at Woolwich for the purpose of ascertaining the comparative strength of gunpowder, was 480 yards.

Horse Power.

The power of a horse is understood to be that which will elevate a weight of 33,000† pounds, the height of one foot in a minute of time, equal to about 90 pounds at the rate of four miles per hour. This is a force greater than that exerted by a common cart horse, which is not estimated at more than 70 pounds: that is to say,

That a horse harnessed to a cart, weighing with its load 40 cwt. or two tons, and drawing on a level road at the rate of 4 miles an hour, makes use of the same force as if his traces, instead of being fastened to a cart, were passed over a pulley, and lifted perpendicularly a weight of 70 pounds.

The expression of the power of the steam engine in horses' powers, is consequently more practical than scientific. It was introduced when steam engines first began to supersede horse mills, when the

* In blasting, a pound of gunpowder is allowed to a foot of bore.

† Another estimate reduces this to only 22,000 pounds, raised one foot high in a minute, equivalent to 100 pounds 2½ miles per hour.

manufacturer naturally inquired, how many horses a steam engine would dispense with?

Man Power.

The strength of an ordinary man walking in horizontal direction, and with his body inclining forward, is only equal to twenty-seven pounds, and it is known by experience that a horse can draw horizontally as much as seven men.

A small animal, or small waggon, is stronger in proportion to its weight than a large one.

Dog Power.

Nine Esquimaux dogs, belonging to Captain Lyon, dragged 1611 pounds, one mile (1760 yards) in nine minutes, and worked in this manner for seven or eight hours a day.*

Draught.

In a four-wheeled waggon of the ordinary construction, on a good road and horizontal plane, the draught is between $\frac{1}{25}$th and $\frac{1}{30}$th of the load. If the load, for example, be one ton, the draught will be between 75 and 89 pounds.†

If a horse, standing still, can by his strength keep a weight of 169 pounds from falling, when suspended over a pulley, he will exert 121 pounds when going two miles an hour, 100 pounds when going three miles an hour, 81 pounds with four miles an hour, 64 pounds with five miles an hour, 49 pounds with six miles, 36 pounds with seven miles, 25 pounds

* It is a curious circumstance in the constitution of these animals, that they have so great a dread of the water as to require a severe beating before they will go into it. In this respect they differ greatly from their neighbours, the Newfoundland dogs.

† Another and more accurate estimate makes the draught equal to $\frac{1}{15}$th of the load.

with eight miles, 16 pounds with nine miles, 9 pounds with ten miles, 4 pounds with eleven miles; 1 pound with twelve miles, and at the speed of thirteen miles per hour he will not be able to exert any power.

On a rail-way the ease of draught is six times greater than on a common road.

On an ordinary canal one horse with a boat will be sufficient for every 30 tons.

A steam engine consumes about 20 feet of steam per minute for every horse power.

Carriage Springs.

Springs of carriages convert all percussion into mere increase of pressure: that is to say, the collision of two hard bodies is changed by the interposition of one that is elastic into a mere accession of weight. It is probable that under certain modifications, springs may be applied with great advantage to the heaviest waggons.

In surmounting obstacles a carriage with its load being lifted over, the springs allow the wheels to rise, while the weights suspended on them are scarcely moved from their horizontal level.

Steam Engines.

One of the largest yet constructed is now in action at the United Mine in Cornwall. It raises 80,000 pounds 100 feet high per minute, with about 30 pounds of coal per minute. It is equivalent to about the power of 250 horses.

The steam engines in England represent the power of 320,000 horses, equal to 1,920,000 men, and being in fact managed by only 36,000 men, add consequently to the power of our population 1,884,000 men. Mr. Watt's great improvement was condensing the steam in a separate vessel, where a vacuum was obtained by the continued application of cold water.

The cost of a steam engine varies according to its power. The smaller cost nearly £100 for each horse power, the largest not quite £40. The consumption of coal is rated at one bushel, or 84 pounds, per hour for an engine of ten horse power; the quantity is somewhat less in proportion in engines of great power.

In a steam boat of 100 horse power, common pressure, 44 feet are required for the engine and fuel. The high pressure engine would only require half that space.

Wolfe's Steam Engines.

These are condensing engines, which work with a power intermediate between high and low pressure. One engine of this description at Whealvor, raises 50,000,000 of pounds one foot high, with one bushel of coals.

The expense of one of the large mines in Cornwall, in 1816, for coals to work their engines, was about £25,000 per annum.

Perkins's Steam Engine.

In the ordinary condensing apparatus, where 1170 degrees of heat are absorbed in generating the steam, 1070 degrees are lost by entering into the condensing water; but Mr. Perkins has contrived a method by which nearly all the heat is absorbed from the steam, and returned to the generator.

The highest that Mr. Perkins has ever used the steam for his engines, is 800 pounds to the inch, or about 57 atmospheres; but in some of the steam gun experiments, a pressure of 1600 pounds to the inch was used with perfect safety.

The great power of Mr. Perkins's steam engines has been established, by the fact of its having lifted a column of water forty feet high and forty inches in diameter with a 9½ inch piston.

Explosive Engine.

This is an engine set in motion by the explosion of oil gas and atmospheric air, the mechanical force of the explosion being employed to drive the machinery. Percussion powder and other substances that explode by contact may eventually be employed for the same purpose.

Brown's Pneumatic Engine.

The principle of this engine is a very sudden expansion and condensation, not of the gases used in the operation, but of the small quantity of water, formed by the combustion of the hydrogen with the oxygen of the atmospheric air, admitted into the cylinder at every stroke of the engine. It is consequently still a species of steam engine with this difference, that the elastic and condensable fluid is generated at a higher temperature from materials admitted into the cylinder itself. The extent of the vacuum produced must depend on the temperature at which the combustion takes place.

Bulk and Elastic Force of Steam.

Under mean pressure, at the temperature of 212° (the boiling point), the bulk of steam is 1800 times that of water; or as a ready rule for calculation, a cubic inch of water produces about a cubic foot of steam. Latent heat of steam about 960°.

At 212° the elastic force of steam is equivalent to the pressure of a column of mercury			- -	30 inch. high.
At 226°	ditto	ditto	-	40 ditto.
238	ditto	ditto	-	50 ditto.
257	ditto	ditto	-	60 ditto.
273	ditto	ditto	-	91 ditto.
285	ditto	ditto	-	95 ditto.

A cubic foot of steam at these temperatures will be

expanded to about 5, 10, 20, 30, and 40 times its original bulk.

One atmosphere is equal to a pressure of 15 pounds on the square inch; 2 of 30; 3 of 44; 4 of 58; 5 of 73; 6 of 87; 7 of 102; and 8 atmospheres of 117 pounds on the square inch.

Power and Velocity of Steam Boats.

The immense increase of power requisite to obtain a small increase of velocity, ought to have its influence in determining the speed of a steam boat during a long voyage, and its proportions ought to be adapted to that speed, with a small excess of power for emergencies. The powers required to give a boat different velocities in still water are as follows:—

Miles per hour.	Horses' power.
3	$5\frac{1}{2}$
4	13
5	25
6	43
7	69
8	102
9	146
10	200

The mechanical power, or power of a steam engine to impel a boat in still water, must be as the cube of the velocity. Therefore, if an engine of 12 horse power will impel a boat 7 miles per hour, it will require one of 35 horse power to impel the same boat at the rate of 10 miles per hour.

$$7^3 : 10^3 :: 12 : \frac{10^3 \times 12}{7^3} = 35$$

The action of what is called a 25 horse power engine, is just equal to the impulse given by 1000 cubic feet of water falling in a minute through the height of 10 feet.

High Pressure.

In a vacuum water boils at about 70°; under common atmospheric pressure at 212°, when the steam ascends from the bottom and carries off the latent heat, preventing any further elevation of temperature.

Add one artificial atmosphere, by loading the escape-valve (the surface of which is equal to a square inch) with 14 pounds, and the water will acquire 250° of heat with a very small addition of fuel, and the pressure on the square inch will be doubled, or 28 pounds. Loaded with four atmospheres or 42 pounds, the temperature will be raised to 280°, with a pressure equal to 56 pounds on the square inch, and so on in proportion to the load.

The principle of high pressure steam engines depends on the power of steam to expand itself 5, 10, 20, 30, 40, &c. times, beyond its original bulk, by the addition of a given portion of heat, which is effected by increasing the pressure.

In high pressure engines the steam is not condensed, but after having acted on the piston is allowed to blow off into the air, whereas in low pressure engines it passes into a separate vessel, where it is condensed; on which account, and for other reasons, low pressure engines do not suit a rail-road. High pressure engines occupy less room, require rather less fuel than low pressure, and their power can be increased on emergencies by merely increasing the fire; but the risk of damage from explosion is considerable. Their principal purpose is to save water, but this is always abundant in navigation. Low pressure engines cease to be such whenever the fire is strongly urged and the valve overloaded.

Rarefaction.

The rarefaction obtained by an air pump, in 1783, went to about the $\frac{1}{1000}$th part of an atmosphere;

some late experiments are said to have carried it to $\frac{1}{3000}$th part.

A Vacuum.

It is well known in mechanics that a vacuum, however produced, is a source of great mechanical power, and it continues to be still the great principle of the engines of the present day: namely, *the creation of a vacuum under or above the piston.*

Bramah's Locks.

A lock of five slides admits of 3000 variations, while one of eight will have no less than 1,935,360 changes; or in other words, that number of attempts at making a key, or at picking it, may be made before it can be opened. This difficulty, great as it is, has been increased an hundred fold by an improvement of his sons. The security of Bramah's locks depends on the doctrine of combinations, or multiplication of numbers into each other, which is known to increase in the most rapid proportion.

Solid Figures.

There can be no more than five regular solid figures, terminated by plane surfaces, which are all similar and equal; viz. the tetrahedron, the cube, the octahedron, the dodecahedron, and the eicosihedron.

Touch.

The ultimate particles of matter never touch, however solid in appearance, and no force can press them into real mathematical contact.

Elastic Bodies.

The further the particles of elastic bodies are drawn from each other until they separate, the stronger they seem to attract, as Indian rubber, which

is the reverse of what occurs in disunited bodies, and the nearer they are pressed together the more they seem to repel.

La Place's Theory of Elastic Fluids.

La Place's theory of elastic fluids is founded on the principle that each molecule is subject to the action of three forces:

1. The attraction of the surrounding molecules.
2. The attraction of the caloric of the same molecules.
3. The repulsion of its caloric by the caloric of the other molecules.

The two first forces tend to make the particles approach each other, and the third tends to separate them. The three states, *solid*, *fluid*, and *gazeous*, depend on the respective predominance of these forces.

HYDROSTATICS, &c.

THE science of weighing fluids, or weighing bodies in fluids. The doctrine of the equilibrium and pressure of fluids.

Hydraulics.

The science of conveying water through pipes.

Pressure of Fluids.

The general rule for estimating the pressure of any fluid is, to multiply the height of the fluid by the extent of the surface on which it stands, and the product gives a mass which presses with the same weight as the fluid standing on that surface, however shallow it may be, provided a portion is supported at the height by a tube.

The pressure of any fluid on a horizontal or level surface is found by multiplying the height or depth of the fluid, by the extent of surface. Thus if the surface be three feet by two, or six square feet, and the height of the fluid three feet, the pressure is equal to eighteen cubic or solid feet of fluid. If it be water, a cubic foot of which weighs 62½ pounds, or 1000 ounces, the pressure is equal to 1125 pounds.

Pressure of Fresh Water.

The pressure of fresh water is always about 13 pounds on every square inch at the depth of 30 feet,

whatever the form or position of the sides may be, and so on in proportion for greater or lesser depths; and if the sides are perpendicular, whatever be the shape, that is, provided the width of the vessel is the same all the way down, the pressure on every square inch of the sides is nearly 13 pounds, at the depth of 30 feet, and so on in proportion for greater or lesser depths.

The Hydraulic Press.

Pascal demonstrated this principle and its advantages, by fixing to the upper end of a cask set upright, a very long and narrow cylinder. In filling the barrel and afterwards the cylinder, the simple addition of a pint or two of water, which the latter was capable of containing, produced the same effect as if the cask, preserving its diameter throughout, had its height increased by the whole length of the cylinder. Thus the increase of weight of a pint or two of water, was sufficient to burst the bottom of the hogshead, by the immense augmentation of pressure it occasioned.

Now, if we suppose the water removed from the cylinder of narrow dimensions, and replaced by a solid of equivalent weight, such as a piston, it is evident that the pressure must remain every where the same.

Again, if we suppose the weight of the piston to be multiplied by the power of a lever acting on its shaft, the pressure will be proportionally augmented, so as to produce on the bottom of the cask a pressure equivalent to an enormous weight, with the exertion of very little primitive force on the piston.

Lateral Pressure.

The pressure on the side of a vessel is equal to the weight of a column of water equal to half the perpendicular height of the vessel.

Power of Water.

If 100 gallons per minute be equal to a certain power with one foot of fall, one gallon per minute will perform the same work with 100 feet of fall.

Balance in Hydrostics.

If you poise in a balance a pitcher full of water, by loading the opposite scale and then hold in the pitcher a block of wood, or any substance nearly the size of the pitcher, but so that it shall not touch its sides or bottom, although nearly the whole of the water will have to run over the sides, and only a spoonful may remain, yet the scales will continue balanced; and all this without regard to the weight of the body you plunge into the water, taking care to hold it entirely clear of the pitcher so that it touch it no where, for the effect will be the same if what you plunge in be scooped hollow and made water tight. A bladder blown up tied fast and held down in the water, so as to leave only a spoonful of water surrounding it, will keep the scales balanced just as well as a block of lead of the same size.

Weight of Water.

A gallon ought to contain ten pounds of pure water; a pint twenty ounces or 31·56 cubic inches.

Capillary Attraction.

If one end of a skein of thread be put into a vessel of water, while the other hangs over the side, it will very soon become a conductor of the liquid, which will filter and run off until the vessel is nearly empty.

Sea Water.

The specific gravity of salt water is 1·026 or 1·028. It freezes about 28·5°, and does not appear materi-

ally to differ in different latitudes, provided it be taken up at a sufficient depth.

Salt Water Ice.

When salt water ice floats in the sea at the freezing temperature, the proportion above to that below the surface is as one to four nearly; and in fresh water ice at the freezing point as one to seven, supposing the base under water does not spread beyond that above water.

Expansion of Spirits.

Spirits expand and become lighter by means of heat, in a greater proportion than water, they are consequently heaviest in winter. A cubic inch of brandy has been found by many experiments to weigh ten grains more in winter than in summer, the difference being between 4 drachms 32 grains, and 4 drachms 42 grains. Liquor merchants take advantage of this circumstance, making their purchases in winter rather than in summer, because they get in reality rather a larger quantity in the same bulk, buying by measure.

Pressure of Water by height.

The pressure of water is not in proportion to its bulk, but only to the height at which it stands, so that a long small pipe containing a pound or two of water, will give the pressure of 20 or 30 tons: indeed twice or thrice as much, if its length be increased and its bore lessened, without the least regard to the quantity of liquid.

POLITICAL ECONOMY.

A SPECULATIVE science in which the wealth of nations is considered, and the causes of its increase or diminution conjectured. It has also been called the Philosophy of Statistics.

Division of Produce.

The whole annual produce of the land and labour of every country, or what comes to the same thing, the whole price of that annual produce, naturally divides itself into three parts: viz.

1. The rent of land.
2. The wages of labour.
3. The profits of stock.

Indications of Prosperity.

There are four circumstances which are the most certain indications of increasing wealth; namely:

1. The accumulation of capital.
2. The increase of population.
3. Improvements in agriculture.
4. The high market price of *raw* produce, occasioned either by a great demand for it in foreign countries or by the extension of commerce.

Taxes.

Taxes on land are paid by the proprietor alone. Extend this reasoning, all taxes whatever fall on the neat surplus of the annual reproduction. Adam Smith admits that no taxes can fall on the wages of labour, even though paid by the labourer, as his

employer must finally replace it to him out of the profits of stock.

Dr. Smith further admits that no tax can fall on the profits of stock, as it must be replaced by the consumers in the advanced price, or by the landholder in diminished rent, or by the monied capitalist in diminished rate of interest.

But interest of money differs in no respect from the immediate profits of stock, it being precisely of the same nature, and, in the operations of national wealth, governed by the same rules. All taxes, therefore, whether imposed on the wages of labour, or upon the profits of stock, are finally paid either by the consumers in increased price, or by the landlord in a diminished rent.

Now, the consumers compose the whole population of the state, and they can only pay taxes, as they pay all other parts of price, from their respective revenues, which revenue must be derived from wages, profit, or rent. But no taxes can fall on profit or wages, therefore those that are levied are all ultimately paid from rent.

We are thus led to conclude from the admission of Dr. Smith, that all taxes, however levied, are finally incident on the net produce, and are ultimately paid by the landlord, either by a diminution of his rent, or in an increase in the wages and prices of labour, which out of his actual rent he distributes among the other classes of the community.*

* A want of clearness pervades all this reasoning, and is indeed a grand defect in modern works on political economy, the language of which has degenerated to a mere jargon, quite unintelligible to common readers, for no two writers attach precisely the same meaning to such terms as *value, price, rent, wages, capital, interest, profits of stock,* &c. &c. on which they ring the changes with words piled on words. It may be said that political economists are not bound to find their readers in brains and comprehension, but when a matter so vitally interesting to the great bulk

Balance of Consumption.

The balance between the produce and consumption of a country, is very different from the balance of trade. It might take place in a country which had no trade at all.

Productive and unproductive Labour.

But if the same quantity of food and clothing, which was thus consumed by unproductive, had been distributed among productive hands, they would have reproduced with a profit the full value of their consumption. The same quantity of money would have equally remained in the country, and there would besides have been a reproduction of consumable goods. There would consequently have been two values for one.

The same capital will put a greater or smaller quantity of labour in motion, according as it is employed in agriculture, manufactures, or wholesale trade.

Corn.

The produce of corn differs from all other commodities in creating its own consumers.

Capital advanced to Government.

Capital advanced to government is turned from productive to unproductive capital. He who advances gets an annuity; but this capital, although

of mankind cannot be understood by common intellects, some mystification, even among the initiated, is to be suspected; "for we are all very desirous of being thought to understand what by competent judges is considered difficult."

Since the appearance of the first edition in 1825, Mr. Malthus published (in 1827) his "Definitions in Political Economy," in which he clearly demonstrates that the late writers on this science not only differ from each other, but frequently from themselves in the same chapter.

apparently new to him, is not new to the country, as it must have existed in it before, and is of course abstracted from other employment. Had they not advanced this capital to government, there would have been two capitals; the one immediately advanced, and the other for which the annuity was sold. Funding actually destroys part of the previously existing productive capital.

Capital.

It is quite as vain (with a view to the permanent increase of wealth) to continue converting revenue into capital, when there is no adequate demand for the products of such capital, as to continue to encourage marriage and the birth of children without a demand for labour and an increase of funds for its maintenance.

Wages.

Corn rises in price because it is scarce; but wages, we are told, rise in proportion. For what purpose? Is it that the labourer shall consume the same quantity as before? This is impossible; for no rise of wages will enable him to consume the same quantity of a scarce commodity.

Money.

The nature of wealth, and the best instruments to measure its increase are such that precision is unattainable; but for short periods, such as four years, money is sufficiently accurate.

General Rise of Price.

If, in consequence of a rise in the price of corn, four shillings will purchase no more home-made goods, of any kind, than three shillings and sixpence

would have done before, neither the circumstances of the landlord, nor those of the farmer, will be much mended by the change.

Colonial Coin.

It was soon found that the price of all goods from the mother-country rose exactly in proportion as the colonists raised the denomination of their coin, so that their gold and silver were exported as fast as ever.

Purchase.

No purchase is ever made either at home or abroad, unless that which is received, is, at least in the estimate of the purchaser, of more value than that which is given.

Barter.

All commercial transactions of dealers are nothing else than barter, the only true buyer and seller being the producer and the consumer. The transit of commodities from the hands of the first seller through those of the dealer, is often multiplied in so many ways before they reach the hands of the consumer, who is the *real buyer*, that it would be quite impossible to prove by calculation what proportion subsists between barter and buying; but the first in all probability greatly prevails over the last, the real buyer and seller appearing but once in the market.

Luxuries.

Taxes on luxuries have no tendency to raise the price of any other commodities besides that of the commodities taxed.

Excess.

No principle can be better established, than that a small excess of quantity operates very powerfully

on price. This is true of all commodities, but of none can it be so confidently asserted as of corn.

When expected supplies are matter of uncertainty, opinion of quantity will act on prices equally whether that opinion be well or ill founded.

Coin and Paper.

Adam Smith compares the coin of a kingdom to the highways through it; neither of them, he says, produce any thing; on the contrary they are both to be kept in repair at a certain expense; but they greatly facilitate the conveyance from one place to another, and from one person to another, of whatever the land produced by agriculture, or what active capital has produced by manufactures and commerce. Paper-money he compares to a waggon way through the air.

Depreciation.

In 1813 and 1814, the depreciation of our currency was probably at its extremest reduction, gold being then from 5*l.* 8*s.* to 5*l.* 10*s.* per ounce. In 1819, when Mr. Peel's bill passed, it was only 4*l.* 2*s.* and 4*l.* 3*s.* Those who take a particular side of the argument, select for comparison, not the actual depression when the bill passed, but the extreme point in 1813.

The Luxury of Idleness.

If the labourer can obtain support for himself and family by two or three days labour; and if, to furnish himself with conveniences and comforts, he must work three or four days more, he will in general think the sacrifice too great compared with the objects to be obtained, which are not strictly necessary, and prefer the *luxury of idleness* to the luxury of improved lodging and clothing. This to a certain degree prevails in India, Ireland, and all countries

where food is plentiful compared with capital and manufactured commodities. On the other hand, if the main part of the labourer's time be occupied in procuring food, habits of industry are generated, and the remaining time, which is inconsiderable compared with the commodities it will purchase, is seldom grudged.

The mere Labourer.

The mere labourer is a competitor with the beast of burthen, and with inanimate mechanic power, his hire being the minimum in the scale of human employment; and thus circumstanced, he is liable to be supplanted by the beast or the machine.

The Seventh Day.

The wages of the labouring classes during the other six days, must necessarily be such as to afford them bread for Sunday. As their wages are invariably reduced to the smallest possible sum that can enable them to subsist, they would get no more were they to work every day. In the latter case the gain would exclusively be their employers', while the labour would be their own.

*Average Prices of Grain.**

	Wheat, per qr.		Barley, per qr.		Oats, per. qr	
1st Jan. 1792,	42*s*.	4*d*.	27*s*.	2*d*.	17*s*.	0*d*.
1st Jan. 1801,	139	0	80	11	43	11
1st Jan. 1804,	52	3	23	11	21	7
1st July, 1810,	113	4	49	9	30	6
1st July, 1812,	140	9	77	0	50	8
1st Jan. 1816,	53	7	25	11	19	9
1st July, 1817,	109	1	55	6	39	0
1st Jan. 1819,	78	10	63	6	35	1
2d Nov. 1822,	38	1	—	—	—	—

* These are selected to exhibit the highest and lowest averages of the last thirty years.

In Mark Lane, in the course of 1801, the price of fine wheat reached the extravagant price of 184*s*. per quarter, and the quartern loaf for four weeks was 1*s*. 10½*d*.

During the winter of 1810, the price of hay rose to 11*l*. per load, and in 1812 the price of oats for a week or two was 80*s*. per quarter.

Average Prices of Beef and Mutton.

	Beef, per stone of 8lbs.	Mutton, per stone of 8lbs.
Jan. 1796,	3*s*. 0*d*. to 4*s*. 4*d*.	3*s*. 6*d*. to 5*s*. 0*d*.
1814,	5 4 7 0	6 0 7 6
1822,	2 8 4 0	2 4 3 8

Cheap Food.

For many reasons, it is desirable that the labouring classes should not be accustomed to feed on the very cheapest and inferior sorts of food, as they do in India and Ireland. On the contrary it is rather to be wished that they should be accustomed to comforts, and even to superfluities.

Food and Intellect.

No country has ever produced a great and civilized race, but one which by its fertility is capable of yielding a supply of farinaceous grain of the first quality. Man never seems to have made any progress while feeding on inferior grains, farinaceous roots, fruits, or the pith of trees. Nations that feed on the three last-named articles appear to possess inferior intellectual capacity to those who feed on the cereal gramina, such as wheat, barley, rye, oats, &c. &c.*

* This is a strong argument against encouraging the cultivation of potatoes, as was done some years ago. Indeed, what is called *encouragement*, is generally premature, misapplied, and detrimental, forcing things on against the course of nature.

Low Prices.

While supplies (of cotton, sugar, &c. &c.) continue to arrive during a series of years of low prices, the presumption is, that the prices, low as they are and have been, are sufficient to defray the cost of production.

Landed Property.

It is totally impossible that the ordinary and general price of food should not command the price of the land that raises it, the labourer who cultivates it, and the farmer who affords the capital and current expenses from day to day. When the quantity sown shall have adapted itself to the supply, all temporary irregularities will pass away, and farmers and landlords will obtain the prices to which, as compared with other articles, they are entitled: for it is not in the nature of things that the general price of the materials of human sustenance should permanently fall short of the cost of producing them.

Land Speculations.

Every purchase of land in Great Britain, previous to 1811, whether made with or without judgment, turned out profitable according to the then market rates: the reverse, until recently, has since been almost general.

Proportion.

It will invariably be found true, that all the great results of political economy respecting wealth, depend upon *proportions*,* and it is from overlooking this most important truth that so many errors have prevailed in the prediction of consequences, that nations have been enriched when it was expected they would

* This observation applies to every action in human life; the difficulty being to find the just proportion or medium, which it is much safer, however, to estimate too low than too high.

have been impoverished, and impoverished when it was expected they would have been enriched.

Economy.

Statesmen, says Mr. Burke, before they value themselves on the relief given to the people by the destruction of the revenue, (by taking off taxes,) ought first to have carefully attended to the solution of this problem; viz.

Whether it be more advantageous to the people to pay considerably, and to gain in proportion, or to gain little or nothing, and to be disburthened of contribution?

Free Trade.

Whilst all our merchants and manfacturers are clamorous for a free trade and an open market, not one of them is willing to surrender to foreigners any restrictions in favour of their own commodities; but is it for a moment to be expected that foreign nations will accede to a treaty under such unequal circumstances?

Old and New Schools of Political Economy.

The new school supposes that the mass of commodities obtained by the same quantity of labour, remains always substantially of the same value, and that the variations of profit are determined by the variations in this same quantity of labour.

On the other hand, Adam Smith and Mr. Malthus suppose that the value of the same quantity of labour remains substantially the same, and that the variations of profit are determined by the variations in the value of the commodities produced by this quantity of labour.

In the one case the varying value of labour is considered as the great moving principle in the pro-

gress of wealth; in the other the varying value of the *produce* of labour.

The labour which a commodity will command is Adam Smith and Mr. Malthus's measure of value: *the labour worked up in a commodity* is the measure of value adopted by the new school.

STATISTICS.

THE present condition of nations, their civil and political constitutions, their wealth, productions, commerce, and population, and their institutions for public instruction.

Income Tax.

Statement of the income tax for the year ending the 5th April, 1801:

By the Commissioners for general purposes		£4,658,491
On income from trade		1,175,836
On ditto from other sources . . .		410,109
		6,244,438
Charges of Collection .	£162,825	
Amount of deductions for children . . .	371,040	
		533,865
		£5,710,572

An account of the gross assessment for the income tax for the year ending the 5th of April, 1801, distinguishing the number and amount of the assessments:

Income.			Number of Assessments.
£60	and under	£65	54,321
65	. .	70	14,728
70	. .	75	23,913
75	. .	80	9,321
80	. .	85	19,639
	Carried forward		121,922

Brought forward		121,922	
£85 and under	£90	7,302	
90	95	11,205	
95	100	7,335	
100	105	24,031	
			171,795
105	110	4,925	
110	115	6,136	
115	120	4,083	
120	125	8,582	
125	130	4,365	
130	135	5,760	
135	140	3,646	
140	145	5,784	
145	150	3,069	
			46,350
150	155	9,203	
155	160	2,184	
160	165	3,761	
165	170	2,082	
170	175	3,647	
175	180	2,035	
180	185	3,758	
185	190	1,884	
190	125	2;680	
195	200	2,320	
			33,554
200	500	42,694	
500	1,000	14,762	
1,000	2,000	6,927	
2,000	5,000	3,657	
5,000	and upwards	1,020	
			69,060
		Grand Total	320,559*

* An income tax, properly modified, is the only fair and impartial tax, as when equally levied, it has no tendency to raise

Parish Relief.

In 1803, the numbers in England and Wales who received parish relief, were as follows:

In workhouses	83,468
Out of workhouses, permanently relieved	336,199
Occasionally relieved	305,809
Children of persons relieved	315,150
Total .	1,040,716

Poor Rates.

The amount of poor rates in England in 1815 was	7,695,534
1822	5,418,815
1826	6,966,000

Saving Banks.

5th April, 1821,

Total received up to this date £3,726,793

Paid back 219,072

On the 5th Jan. 1822, there was standing in the names of the Commissioners, on account of the Saving Banks of England only, £5,877,000.

On the 12th April, 1823, the deposits of Saving Banks paid into the Bank amounted to £7,323,179.

Copy Right.

The British Museum, Sion College, the Bodleian, the Public Library at Cambridge, the Advocates'

general prices, and every other presses more or less on particular classes. The true reason of its being so unpopular and so difficult of collection is, that it puts the honesty of human nature to too severe a trial.

On the 5th Jan. 1814, the income tax produced £14,316,816; the expense of collection was only £306,158, or about £2 : 2s. per cent. In 1823 the average expense of collecting the customs and excise was 7 per cent.

Library at Edinburgh, the four Scottish Universities, Trinity College, and the King's Inns' Library, (total, eleven,) each take, or rather extort, a gratis copy (from a class* poor to a proverb) of every book entered at Stationers' Hall, where one must be deposited to secure the copy-right.

The Guards.

The total charge, including clothing, &c. for a year, of a regiment of life guards, consisting of eight troops, of one farrier and 42 men per troop, and 274 troop horses, was, in 1821, ...	£32,000
Ditto, ditto, of a regiment of horse guards	30,188
Ditto, ditto, of a regiment of dragoons, 46 rank and file, per troop	24,835

Half Pay.

In Feb. 1819, the half pay officers of the army amounted in number to 7908, and the half pay of the army of all descriptions to £2,503,174.

Dividends.

An account of the number of persons who received half-yearly dividends in A. D. 1823.

Not above £5	 92,223	persons.
10	 42,083	
50	 101,274	
100	 26,410	
200	 15,604	
300	 5,170	
500	 3,260	
1000	 1,741	
2000	 490	
Above . 2000	 218	

Not including money in the Saving Banks, nor that

* Authors.

standing in the name of the Commissioners for the reduction of the national debt.

The total number of persons receiving dividends was 288,473, of whom 277,594 persons were in receipt of various incomes from the funds under £400 per annum, and 10,879, of incomes above that sum. The number of persons receiving from £1000 to £2000 per annum was 490, and of those receiving more than £2000, only 218 persons,

Of the 800 millions national debt, only about 175 millions is fluctuating; the remainder consists either of wardship in Chancery or the Exchequer, or belonging to charities, trusteeships, or the fixed property of individuals who rarely sell or transfer it.

East India Stock.

The proprietors of East India Stock consist of about 3000 persons. Those whose stock does not amount to £1000, are not allowed to vote, that amount being a qualification for one vote. £3000 stock qualifies for two votes; £6000 stock for three votes; and £10,000 stock or upwards for four votes. In 1810, according to the existing list, 1662 were qualified to give single votes; 326, double votes; 84, triple votes; and 51, quadruple votes. The total number of votes, therefore, was 2770; but as many proprietors are absent from England, and others do not attend, more than 1900 have never voted, and, indeed, that number may be considered as a maximum.

Generally speaking, ten years must elapse after his election, before an East India director can become a member of the Committee of Correspondence, preous to which he is attached to one of the junior Committees of Detail, which have no connexion with the larger questions relating to the general administration of India, except when those are agitated in court.

The patronage of each East India director for the year 1826, was estimated at £20,200 sterling.

Three per Cent. Consols.

This stock was at the highest in June, 1737: viz. 107
And at the lowest in June, 1797: viz. . . . . $47\frac{1}{2}$
In 1792 it was 96
In April, 1824 . . . . $96\frac{3}{4}$

The three per cent. Consols, which had risen in March, 1783, immediately after the peace, to 68, fell by the close of the year to 58, eventually to 54, and continued under 60 until September, 1785.

Bankruptcy.

For want of a decided rectitude of conduct, a commercial house, which would at first have (if the expression may be used) failed honestly for £10,000, after long struggling and procrastination, becomes bankrupt for £100,000, by which they ruin many firms and families, who in their fall crush others.

Revenue of Scotland and Ireland.

The revenue of Scotland, in 1812, was	£1,519,892
The expense of collecting	361,000
The revenue of Ireland, in 1812, was .	5,705,815
The expense of collecting	883,000

Advertisements.

1820-21,	Clear revenue from advertisements in newspapers .	£137,000
	Ditto from newspaper stamps .	351,000

Legacy Duty.

The amount of the tax on legacies in 1823, was	£990,787
Ditto on probates of wills	706,805

New Churches.

The estimate for accommodation in several of the new churches is assumed at nine pounds per head.

Income of the English Dioceses.

	Per annum.		Per annum.
Canterbury .	£24,000	Oxford . .	£3000
York . . .	14,000	Lincoln . . .	5000
Durham . .	24,000	Salisbury . . .	6000
Winchester .	18,000	Norwich . . .	4000
Ely	12,000	Carlisle . . .	3500
London . . .	9000	St. David's . .	5000
Bath and Wells .	5000	Rochester . .	1500
Chichester . . .	4000	Exeter . . .	3000
Lichfield and Coventry .	6000	Peterborough .	1000
		Bristol . . .	1000
Hereford . . .	4000	Llandaff . . .	900
Bangor	5000	Gloucester . .	1200
Worcester . . .	6000	Chester . . .	1100
St. Asaph . . .	6000		

Patronage of Church Livings.

Although there appears to be only 9284 parish churches in England, there are 11,593 benefices; 1200 of which are in the patronage of the diocesans; 1005 in deans and chapters; 103 in the five colleges of Manchester, Rippon, Southwell, Westminster, and Windsor; 583 in the universities of Oxford and Cambridge, Eton and Winchester; 1015 in the King, Prince of Wales, and Duke of Lancaster; leaving 7597 in the patronage of lay impropriators.

Knights of the Bath.

Since 1816 the order of the Bath has consisted of 68 military knights grand crosses, and 12 civil; 196 knights commanders, and 520 companions.

Royal Society.

On the 30th Nov. 1815, the number of ordinary members on the election list of the Royal Society was 580; that of foreign members, 43; total, 623.

Public Schools.

1824.	Number of boys at Eton school .	550
	Ditto at the Charterhouse	450
	Ditto at Winchester	270
	Ditto at Westminster	250*

1822. *Attorneys.*

Total number of attorneys in London .	1800	
Ditto ditto in the country	2400	
	——	4200
Total number of barristers in England, about .		900

Drury Lane Theatre.

The boxes in the new Drury Lane Theatre will hold 1200 individuals; the pit, 850; the lower gallery, 480; the upper gallery, 280; in all, 2810 persons can be accommodated.†

Court of Chancery Wardships.

Amount in the Bank standing in the name of the Accountant General to the Court of Chancery at different periods during the last one hundred years:

A.D. 1726	£741,590
1730	1,007,293
1740	1,295,243
1760	3,093,740
1780	7,120,537
1800	17,565,912
1805	21,635,719
1810	25,162,430
1815	32,018,209
1820	34,208,785
1825	39,174,722

* 1825, Members of the University of Oxford . . 4660
Ditto ditto of Cambridge . 4700

† This estimate was made ten years ago, and is inserted principally to show the relative proportions of the pit, gallery, and boxes, to each other.

Municipal Debts.

In 1824, the debt owing by the City of London was	£640,000
Ditto by the Corporation of Liverpool	400,000
Debt owing by the Liverpool Docks	662,873

The richest corporation in England is that of Liverpool; the next is said to be Newcastle on Tyne, London being only the third.

The Common Council.

The court of common council consists of

Aldermen	26
Common councilmen	226
Total	252

National Debts.

Denmark, about	£10,000,000 (*a*)
United States	19,000,000
Columbia	6,750,000
Chile	1,000,000
Peru	1,200,000
Buenos Ayres	1,000,000
Brazil	3,200,000
Mexico, 1825	6,400,000
Austria, in 1819	83,790,000 (*b*)
France	170,000,000
Spain	111,570,000 (*c*)

(*a*) Of this amount £5,000,000 is the paper of the bank, for which the government is guarantee. Four-fifths of the debt is owing to Danish subjects.

(*b*) This sum includes paper currency of the nominal value of £20,000,000, which in 1819 was greatly depreciated. Part of the Austrian debt pays only 2½ per cent. interest.

(*c*) Viz.—Funded debt £59,460,000; Vales Real £52,110,000 =111,570,000*l.* sterling. These Vales pay no interest. The

Portugal	£12,000,000	(a)
Prussia, in 1819	24,000,000	(b)
Russia (roubles 1,000,000,000)		(c)
Bavaria	9,000,500	(d)
Wurtemburgh	3,000,000	
Saxony	4,000,000	
Hanover	3,000,000	
Switzerland	2,000,000	(e)
Naples	18,000,000	
The Papal Dominions	19,000,000	(f)
Tuscany	5,000,000	
Sardinia and Savoy	1,650,000	
Sweden, 1819	1,380,000	
Norway		(g)
Greece, 1825	2,800,000	
East India Company's debt	30,000,000	
Netherlands (Holland and Belgium)	170,000,000	(h)
Great Britain	842,000,000	

loans made by the Cortes are not included in the above statement.

(a) Besides £2,000,000 circulating paper of the government.

(b) A portion of this has since been paid off.

(c) Of this amount 600,000,000 of roubles consist of a depreciated paper-currency, not worth one-fourth part of its nominal value.

(d) Besides the above, several of the provinces that were independent states have their respective debts, all guaranteed by the king.

(e) Switzerland has properly no national debt belonging to the Union, but each of the cantons have national debts, the amount of which is kept secret, but the whole is supposed to amount to about £2,000,000 sterling.

(f) Including the paper-money issued by the former Popes.

(g) The interest of the national debt of Norway is said to be only £10,000 per annum.

(h) Of this, above five-eighths pay no interest. See *Dutch National Debt.*

National Debt of Great Britain.

1816.	Total amount of the funded debt	£816,911,000
	Unfunded debt	47,912,000
		£864,823,000
1823.	Total amount of funded debt	£796,539,000
	Unfunded debt	45,526,000
		£842,065,000*

Total apparent reduction since 1816, £24,766,000; but the actual reduction was £35,000,000.

Dutch National Debt, 1822.

	Florins, 2s.
Deferred debt, on which *no* interest is paid	1,131,000,137
Active debt, bearing interest	510,000,000
Belgian debt	34,466,816
Total .	1,675,466,953

Or nearly £170,000,000 sterling.

The expenses of the finance department (including 25,000,000 Rhenish florins, about 2*s.* value, the interest of the national debt) was £7,500,000 per annum.

The French National Debt.

The annual interest of the French national debt on the 1st Sept. 1821, was 263,900,284 francs, about £11,500,000.

* In 1822 this amount was said to have stood in the names of 280,000 persons.

American National Debt.

The national debt of the United States of America amounted, in A.D. 1791, to 75,463,000 dollars.
1812, to 45,209,000
1816, to 127,334,000
1823, to 90,875,000

Revenue from Taxation.

An account of the gross receipt derived from taxation in Great Britain (drawbacks, and payments of the nature of drawbacks, deducted; exclusive of all loans, and of payments received from Ireland and Austria) in each year since Jan. 1815:

1815	£70,422,151	1821	£54,638,141
1816	61,437,257	1822	53,823,511
1817	51,183,134	1823	52,561,802
1818	52,717,933	1824	52,685,930
1819	51,385,950	1825	53,951,463
1820	54,058,666		

Canals and Rail Roads.

In 1823, the total length of canals in Great Britain, excluding those under five miles, was 2589 miles. Taking the average of 75 canals, the cost of making has been estimated at £9000 per mile; common rail roads at £5000 per mile; the Liverpool and Manchester rail road at £12,000 per mile.

On a well-constructed level rail road an ordinary horse will draw, with considerable ease, a load of seven or eight tons 2½ miles per hour, or eleven tons at the rate of two miles per hour: on a canal the same horse will draw thirty tons 2 miles per hour. But the resistance to any body in the water increases as the square of the velocity; besides which, a horse, when put to the speed of four miles an hour, exerts a diminished force. It would therefore require six

horses to draw along a canal, at the rate of 4 miles an hour, the same load that one horse could draw at the rate of 2 miles an hour.

At the speed of 2⅗ths miles an hour, the rail road and canal, with the same moving power, are nearly equal: but at 3 miles per hour the rail road has the advantage as 11 to 10, and at 9 miles an hour as 8 to 1.

An eight horse-power engine dragged the following weight on a rail road at the rate of 7 miles per hour: viz.

	Tons.	Cwt.
Coals	33	13
Weight of the waggons	15	2
Ditto of the engine, &c.	9	0
	57	15

Turnpike Roads.

In 1823 the total extent of turnpike roads in Great Britain amounted to 24,531 miles; the annual income to 1,214,716*l.*; the debt to 5,200,000.

Caledonian Canal.

Up to the 31st Dec. 1822, 950,000*l.* had been expended on this canal.

This canal exclusive of locks is 21½ miles long, has about 15, but is intended to have 20 feet depth of water, and has 22 locks. Its summit level is 93 above that of the sea.

Forth and Clyde Canal.

The estimate for making the Forth and Clyde canal was only 100,000*l.*; but it required no less a sum than 421,525*l.*, of actual outlaid money to complete it, although two-thirds of it were nearly

finished half a century ago. The proprietors of this canal received no dividends or returns for their money, for thirty-two years, nor have they since received 2½ per cent. on what their shares have cost them including lost interest. 421,525*l.* at compound interest would have amounted to two millions sterling when the dividends commenced paying.

The Languedoc Canal.

The Languedoc canal is 152 miles long, and six feet deep, and was finished during the reign of Lewis XIV., at an expense of 650,000*l.* It has 100 locks, and its summit level is 639 feet above the level of the sea.

Rent above and below Ground.

One-third of the produce is the common rent of an estate above ground; but only one tenth of the produce of a coal mine.

Coals.

The Newcastle coal formation extends in length 23 miles, containing altogether 557,568,000; the whole coal in this formation amounts therefore to 5,575,680,000 cubic yards. The quantity of coal exported annually 2,000,000 of chaldrons.

A chaldron weighs 25 cwt., so that 28,000,000 tons of coal are annually raised. A ton of coal is nearly one cubic yard, so that the yearly loss from mining amounts to 28 millions, or (adding 3 for waste) to 31 millions of cubic yards. The result is, that the Newcastle mines, at the present rate, are capable of supplying coals for one thousand years.

Cowries.

In Soudan or Central Africa cowries were exchanged at the rate of about 2,000 for a Spanish dollar. This shell, which forms an excellent medium

among many nations widely separated from each, has the recommendation of being inimitable and unforgeable.

Docks.

The West India outward bound dock contains 24 acres
ditto homeward bound 30

The total cost was about 2,200,000*l.*

The London dock contains 20 acres, and cost about 2,000,000*l.*

The East India dock contains 18 acres, and cost about 600,000*l.*

Life Annuities.

Various tables of life have been constructed, but that formed from observations on the duration of human life among the inhabitants of Northampton has for many years been the basis of the premiums taken by most of the assurance companies.

Last century the general proportion of deaths was reckoned one in 32, and that of births as one in 28. In 1825, of a certain number of children born in Europe there die the first ten years 38 per cent. instead of 50 per cent. as formerly. At present 66 per cent. die before reaching fifty years of age, formerly the ratio was 74 per cent. Twenty-three persons in the hundred now attain sixty years of age instead of only eighteen as formerly.*

Occupations.

In A. D. 1810 there were 770,199 families occupied in agriculture; 959,632 in manufactures, handicraft and trade; and only 413,316 in other employments.

In A. D. 1821 there were 773,732 families occupied in agriculture; 1,118,295 in manufactures, handicraft and trade; and only 454,690 in other employments.

* It is said the nation has lost between two and three millions by the annuities sold by government.

Official Value.

The official value of goods is always the same. It has been adopted at the Custom-house, and retained for a century past in the public accounts, merely for the purpose of showing the increase or decrease of trade from year to year, and has no reference whatever to the real value of goods. It was formerly the custom to add fifty per cent. to the official value in order to get the real value; but at present (1819) the real, or at least the declared value, is said to be actually lower on an average than the official.

Importers smuggle in; exporters magnify their exports: the last in consequence appear greatly to over-balance the first.

Gilding.

Fifty thousand pounds worth of gold and silver, are said to be annually employed at Birmingham in gilding and plating, and of course for ever lost as bullion.

Cotton Yarn.

Cotton yarn has been spun to the fineness of 350 hanks weighing only one pound. Each hank would measure 840 yards, which multiplied by 350, will give 294,000 yards, or 167 miles and a fraction.

1,140,000 bales of cotton were imported into Europe during the year 1825.

Quick Work.

Sir John Throgmorton sat down to dinner dressed in a coat which had that morning been wool on the sheep's back.

East India Trade.

The act for opening the East India Trade passed in 1813, the first licenses were granted the 12th of April, 1814.

The Tea Trade.

The quantities and average prices of teas sold by the East India Company in 1823.

	Quantity sold.	Average price.
Bohca . . .	1,904,435 pounds .	2 4¾
Congou . . .	16,681,814	2 7¾
Campoi . . .	408,769	3 6
Souchong . .	1,285,230	3 6½
Pekoe . . .	46,005	5 3¾
Twankay . .	4,158,355	3 5
Hyson skin . .	319,425	3 4½
Hyson . . .	916,846	4 4

Sugar.

The annual consumption of sugar in England is above 20 pounds each person.—Indeed, with the exception of bread corn, it is probable that the consumption of the British empire of all other articles exceeds that of the whole continent of Europe.

One cwt. of sugar is equal in nutriment to a quarter of barley or $\frac{8}{11}$ of a quarter of wheat.

NAVIGATION.

The act and practice of passing by water.—The act of conducting a ship on the water.

British Tonnage, A. D. 1812.

	Tons.	Men.
England	1,951,234	. . . 124,896
Scotland	231,273	. . . 16,300
Ireland	57,104	 5,320
	2,239,611	146,516
Colonies	239,188	. . . 18,514
	Tons 2,478,799	Men 165,030

		Tons.
1815	Registered tonnage of Great Britain	2,480,000
1819	. . . . ditto	2,666,336
1820	. . . . ditto	2,648,592
1821	. . . . ditto	2,560,202
1823	. . . . ditto	2,506,760
1825	. . . . ditto	2,542,000

The average outward tonnage during the war was 1¾ millions of tons; the same average for 1819-20-21 exceeds two millions.—The average inward tonnage during the war was about 1,800,000 tons; the same average in the above years exceeded 2¼ millions.

American Tonnage.

	Tons.
1821. Amount of the import* tonnage in American ships	765,000
ditto . . . export . . ditto	804,000

Average Voyages.

	Days.
Average length of a voyage out and home to Batavia	300
ditto . . . . . ditto . . . Bombay	320
ditto . . . . . ditto . . . Bengal	365
ditto . . . . . ditto . . . China	365

First Rates.

In A. D. 1667, ships of the first rate, or 100 guns, were from 1500 to 1600 tons burthen.

In 1720, they were increased to 1800 tons; in 1745, they advanced to 2000 tons; during the American war to 2,200 tons; in 1795, the Ville de Paris of 110 guns, measured 2350 tons; in 1804, the Hibernia of 110 guns, was extended to 2500 tons; and in 1808 the Caledonia, carrying 120 guns, measured 2616 tons; since which date the Nelson, the Howe, the St. Vincent, Britannia, Prince Regent, Royal George, and Neptune, have been built, or ordered to be built, of the same size and draught nearly.

The Caledonia.

Length of the gun deck 205 feet; of the keel 170 feet—Extreme breadth 53 feet 8 inches; depth in the hold 23 feet 2 inches—Burden 2616 tons.

* It would have been more satisfactory to have had the registered tonnage.

The following is the armament of the Caledonia:

On the gun deck she carries	32 guns	32 pounders.
Middle deck	34	24
Upper deck	34	24
	100	
Quarter deck	10	32
ditto	6	12 carronades.
Forecastle	2	32
ditto	2	12 carronades.
	120 guns.	

Her proper complement of men is 875.

The Commerce de Marseilles.

Gun deck 208 feet; keel 172; breadth 54 feet 9½ inches; depth 25 feet;—burden 2747 tons.

Chinese Junks.

The Chinese junks are partitioned into water-proof divisions, so that although there may be a leak in one, it does not affect the others.

The Log Line.

The log line used on board his Majesty's ships is 48 feet long, and the sand glass runs 28 seconds.

Steam Boats.

The first American steam boat that completely succeeded was launched at New York the 3d October, 1807.

The first steam boat brought into use in Great Britain, was the Comet, in 1812, with an engine of only three horse power, being intended for passengers.

In 1823, the Soho, of 510 tons, plying between

Leith and London, (460 miles,) with two engines, each of 60 horse power, total 120, was the largest belonging to Great Britain.

The Chancellour Livingstone, at New York, is 520 tons, with a high pressure engine of 75 horse power.

The Lady Sherbrooke on the St. Lawrence is 787 tons, with a high pressure engine of 60 horse power.

The Savannah, in 1819, crossed the Atlantic to Liverpool (about 4000 miles) in 21 days, during 18 of which the engine was going, and consumed ten tons of coals per day.

The St. George, Liverpool to Dublin, 312 tons, two engines 55 horse power each=110 horse power.

The St. Patrick, Liverpool to Dublin, 208 tons, two engines 55 horse power each=110 horse power.*

On board of a steam boat, a boiler constantly in use, with care, will last from four to five years. The engine usually makes about 29 strokes per minute.

Ship Building.

It must be confessed, that as far as the form of a ship's bottom depends on scientific principles, we have copied our best models from the French, sometimes with capricious variations, which more frequently turned out to be rather injurious alterations than improvements.

Copper Bottoms.

Rodney's fleet in the West Indies, in 1799, had but four coppered ships; but in 1782 the whole British navy was coppered.

* From Leith to London, 495 miles, has been done in calm weather by steam boats in 47 hours.

The Dry Rot.

The spaces between the frame timbers are now filled up with prepared cement, which renders the lower part of the ship (the floor) one solid mass, possessing the strength and consistence of a rock.—Formerly these intervals were receptacles for every description of filth, mixed up with dead rats, mice, cock-roaches, and other vermin, causing an intolerable stench, and promoting the decay of the timbers.

By stuffing masses of the above cement between the timbers, and then injecting by forcing-pumps a mixture of oil and tar into all the joints and crevices of the frame of a ship, and by increased care and attention, the dry rot may be said to have no longer any existence in the British navy.

A new ship built of green timber, and sent to Petersburgh for a cargo of hemp, will become completely rotten in a couple of voyages; whereas the same ship, if employed in carrying coal and lime, would probably last half a century.

British Navy.

In 1821, the number of ships and vessels of every description in commission, in ordinary, building, repairing, and ordered to be built, had been reduced to 609 sail.

The number of seamen and marines voted in 1822, was 21,000.

The total expense of the navy in the middle of the late war was about 18,000,000*l.*

In 1822, it was about 5,000,000*l.*

Starboard and Larboard Tacks.

The law, as declared by the Court of Admiralty, is,—that the vessel on the starboard tack is to keep her wind;—and the vessel on the larboard tack

is bound to bear up, or heave about to avoid danger.—If the latter does not give way, her owners will be answerable for any injury the vessel on the starboard tack may sustain by their coming in contact.

Masts and Yards.

	Ft.	In.
Suppose the extreme breadth of beam of a 44 gun frigate to be	43	6
Multiply by		2
Length of the main yard	87	0
And one-sixth of the sum . . .	14	6
Length of the main-mast	101	6
Foremast	93	8
Mizen-mast	93	8
Mainyard	87	0
Foreyard	82	0
Bowsprit	62	0

Hollow masts of iron for the navy are now constructing as an experiment.

Admiral of the Red.

There is no admiral of the red squadron, the red flag having been laid aside on the union of England and Scotland, when the union flag was adopted in its place, and is usually hoisted by the commander-in-chief.

Green Water.

Green water at sea generally indicates shallows, and blue a deep sea.

Captain Parry's Voyage.

In Captain Parry's voyage of 1819-20, the great-

est westing reached was 113° 46′ W. but they could see to about 117° W.

The greatest heat, that for part only of one day, was 60° Fah., the greatest cold was minus 55° below zero, or $-55+32=87$ degrees below the freezing point,* yet with proper precautions they never suffered materially from exposure to the open air.

On the shortest day at noon, very small print could be read with tolerable ease, by turning the book directly to the south; and they could walk out by twilight very comfortably for two hours about noon.

Greatest Northing and Southing attained.

Captain Phipps (afterwards Lord Mulgrave) went so far north as 80° 36′ N.

In 1806, Captain Scoresby, in a Greenland ship, penetrated to 81° 30′ N. Farther than this there is nothing that can be depended on.

Captain Cook's greatest southing never exceeded 71°. The late Russian antarctic expedition of 1822, only reached to 70° S., but on the 20th February, 1823, Captain James Weddel, of the brig Jane of Leith, reached the high latitude of 74° 15′ S., where he found the sea almost free from ice, viewed in clear weather from the mast head.†

* Captain Franklin's party experienced a cold of $-57+32=89$ degrees below the freezing point, and, besides being destitute of food, were without any protection against the inclemency of the weather. The result of this expedition tends to prove, that the human frame is capable of supporting a much greater intensity of cold than had previously been supposed.

† Captain Weddel says that the weather continued mild and serene, and not a particle of ice of any description was to be seen, until the 20th February, when in lat. 74° 15′, lon. 34° 17′; then ice islands were seen, three degrees further south than Captain Cook had attained.

Point Turnagain.

Point Turnagain, from whence Captain Franklin returned, is in latitude 68° 34′ N., longitude 109° 25′ W.

Ice Bergs.

The altitude of one ice berg seen in Captain Parry's Voyage of 1821-22, was 258 feet above the surface of the sea, its total height, therefore, (allowing $\frac{1}{7}$ to be visible,) must have been 1806 feet.—This, however, is on the supposition, that the base under water does not spread beyond the mass above water, but descends perpendicularly, which is improbable. An approximation might apparently have been gained by sounding, to discover if the depth actually amounted to 300 fathoms.

A decrease of wind immediately takes place to the lee of ice, whether as a stream, sheet or in large pieces. In the polar regions, which are encumbered with them, there is a total absence of heavy or dangerous squalls of wind, never obliging the seaman to lower his topsail.

Lieutenant Ross, in Captain Parry's third voyage, tried the thickness of the salt-water ice by digging holes—the greatest thickness was 7 feet 2½ inches, on the 4th May, 1825.

Refraction.

The refractive powers of the atmosphere are so fluctuating as to render it impossible at all times to ascertain correctly, or by any invariable rule, the distances of terrestrial objects by their heights, or their heights from the distances at which they may be visible to the eye. This influence is probably most powerful in the polar regions.—The highest land seen by Captain Ross in Baffin's Bay, he estimated at only 4000 feet, yet during the voyage it was clearly ascertained, that objects were sometimes

discerned at a distance exceeding 150 miles. Now it requires an elevation of 28,000 feet to render an object visible at the distance of 200 geographical miles.

The high rock of Cape Dudley Digges was observed to rise from 2° to 5° within an hour, and in the next half hour it descended in appearance nearly to the level of the water.

In estimating the depression of the horizon of the sea, corresponding to the different heights of the observer's eye, the horizon is supposed to be raised by terrestrial refraction *one fourteenth part* of the depression due to the spherical figure of the earth, and the corrections for different heights, rigorously computed, are reduced accordingly in that proportion in the best tables.

British and Foreign Ships entered in 1825.*

	British.	Foreign.
At London	758,565 tons	302,122 tons.
Liverpool	315,115	222,187
Hull	328,204	100,733
Leith	57,230	55,276
Greenock	51,249	6,229

Of the above amount of foreign tonnage, the following amount belonging to particular states arrived in England, viz.—

To Prussia	151,790 tons.
France	49,067
United States of America	178,949
Norway	140,334

* This statement refers only to five of the principal seaports, but furnishes a comparative estimate of the whole.

WAR, &c.

THE exercise of violence under sovereign command; forces; army; the profession of arms.

Art of War.

Jomini has demonstrated that the art of war reposes on one fundamental principle or maxim, which is, "the effecting with the greatest mass of forces a combined operation on a decisive point."

Waterloo.

18th June, 1815—British troops of the line engaged in the battle	40,000
Hanoverians, Brunswicker's, Belgians and other troops under the command of the Duke of Wellington, about . . .	50,000
Total	90,000
Killed and wounded of the British, about .	10,000
ditto of the auxiliaries in the British line, about	4,500
Total	14,500
Killed and wounded of the Prussian army in the previous conflicts of 4 days, about	22,000
Total killed and wounded	*36,500

* This is extracted from the Report of the London Committee for the Waterloo Subscription, dated the 27th October, 1815, and is probably very near the reality.

Fortresses.

In defensive war the gaining of time from a variety of military and political considerations is a most important acquisition; which may, and probably in most cases does, compensate for the loss of a fort captured by the enemy with breached ramparts, broken counterscarp, filled ditch, ruined interior, expended stores, accompanied by a disproportionate injury necessarily sustained by a large army compared with the garrison.

Vestiges.

In future ages the ruins of modern fortifications will make no show compared with the ancient elevated structures for defence.

Bombs.

The inequalities of the inner surface of a rocky hill fort, keep a bomb-shell in constant motion until it explodes—the hollow parts, consequently, which are the most secure against shot, suffer most from a bombardment, which keeps the besieged in a state of constant and harassing motion.

Telegraphs.

During the late war there were 12 stations between London and Portsmouth, and 31 between London and Plymouth, of which eight were on the Portsmouth line, and separated at the New Forest. From London to Deal there were 10 stations, and 19 to Yarmouth—the distances average about eight miles, but some extend to twelve or fourteen miles.

After about 20 years' experience, it has been estimated that for 200 days in the year signals can be transmitted throughout the day; about 60 on which they pass only part of the day, and 100 days on which few of the stations can see the others.

The transmission of a message from London to Portsmouth during the war, usually took place in 15 minutes, but by an experiment tried for the purpose, a single signal has been transmitted to Plymouth and back again in three minutes, which by the telegraph route was at least 500 miles.—In this instance notice had been given to make ready, and each captain was at his post.*

The number of signals conveyed by the English telegraph is 63, by which they represent the ten digits, the letters of the alphabet, many generic words, and all the numbers expressed by the combination of the digits 63 ways.—The observers at the telegraphs are not required to keep their eye constantly at the glass, but only to look every five minutes for the signal to make ready. The expense of 64 stations at 150*l.* per annum each, was about 10,000*l.* yearly.

 general preparation make ready

 message not understood

 affirmative—yes

 no—negative and annul

 ship's name

 alphabet

Giving Quarter.

This phrase originates from an agreement between the Dutch and Spaniards, that the ransom of an

* The electric fluid has been conducted by a wire four miles in length apparently instantaneously, and without any diminution of effect. If this should be found to be the case with the *Galvanic* circuit, an *instantaneous* telegraph might be constructed by means of wires and compasses.

officer or soldier should be a quarter of his pay.—Hence to beg quarter, was to offer a quarter of their pay for their safety, and to refuse quarter was not to accept that composition as a ransom.

Stratagems.

Gibbon says: In the field the Sclavonian infantry was dangerous from their speed, agility and hardiness; they swam, they dived, and remained under water, drawing their breath through a hollow cane. In this manner a lake or river was often the scene of their unsuspected ambuscade.*

* This extract furnishes a valuable hint for the improvement of modern tactics; and the manœuvre might be advantageously practised by the Life Guards, (dismounted,) in the Serpentine.

GEOGRAPHY, HYDROGRAPHY, &c.

DESCRIPTION of the Earth.—Delineation of the watery portion of the terraqueous globe.

The Ocean, its Depth, and Temperature.

The ocean, with all its islands, bays, and seas, covers an area of 145,600,000 English square miles, or nearly $\frac{4}{5}$ths of the surface of the globe.

Laplace has calculated that its mean depth is but a small fraction of the difference of the axes of the earth, which difference is 25 miles. If, therefore, we suppose the mean depth to be two miles,* the cubic contents will be 290,000,000 of cubic miles.

In A.D. 1819, in lat. 4° N. at the point where the approximation of the two continents of Africa and America is nearest, Sir Thomas Hardy, in the Superb, sent down 2000 fathoms of whale-line, with six cwt. attached. At first it ran out with great rapidity, but afterwards sluggishly. After the rope that had sunk with its own weight was drawn in, about 1500 fathoms appeared to be down perpendicularly, when the line, owing to the prodigious strain on it, broke, and it remains uncertain whether the weight attached had reached the bottom or not.†

* This seems too high an average for the depth of the whole ocean. Dr. Keill computes the surface of the whole ocean to be 8,549,050 square miles, with an average depth of a quarter of a mile; and even this is probably too high an estimate.

† Ten, or at most twelve, fathoms is the very lowest a diving-bell dare venture to go, the density, and more especially the heat of the air, although renewed by the forcing-pumps, become so insupportable.

Captain Wauchope, of His Majesty's ship Euridice, when within a few degrees of the equator, sent down during a calm 1400 fathoms of line, but estimated the perpendicular depth at only 1000 fathoms. On drawing up the instrument, he found the enclosed thermometer marked 42°, while the temperature of the surface was 73° Fahrenheit.

In 1823, Captain Sabine found the temperature of the water, at a depth of 6000 feet, in lat. 20° 30′ N. long. 83° 30′ W. near the junction of the Mexican and Carribean seas, to be 45° 5′, that of the surface being 83°. He conjectured, that in one or two hundred fathoms more, the thermometer would have descended to water at its maximum of density (42°,) so far as depended on heat.

Pacific Ocean.

The Pacific Ocean, in consequence of its wide expanse, is remarkably exempt from storms, except near such of its shores as are mountainous; hence its name.

Mediterranean Sea.

The Mediterranean Sea expends by evaporation three times more water than it receives. Its surface, depressed by this constant drain, is said to be 34 feet lower than the Red Sea, and hence powerful currents rush in from the Black Sea by the Dardanelles, and from the Atlantic by the straits of Gibraltar, to restore the level. To this cause also its superior saltness is owing, the fresh water being carried off from the surface by evaporation. Like all inland seas that open to the west, it has no general tides, but local tides of from one to three feet. The mean rise of the tide in the Red Sea, is six feet; that of the Mediterranean, thirteen inches.

Caspian Sea.

The surface of the Caspian Sea, is 334 feet (a French author says 50 toises) beneath that of the Black Sea, and its shores may perhaps be considered the lowest country in the world.

Lake Superior.

Lake Superior is 617 feet above the level of the Atlantic, and 52 feet above Lake Erie. Extreme length, 541 miles; extreme breadth, 140 miles.

Tides.

In the open sea, the tides are at their height three hours after the moon has passed the meridian of the place, and of the meridian opposite. They are smallest towards the poles, and greatest towards the equator, where, however, they do not exceed two or three feet in the great ocean. Their greatest elevation takes place in the narrow seas, when the action of the moon is aided by winds and currents, the position of the coast, &c. The highest tides in Europe are in the Gulf of St. Maloes, where the flood, driven back by the coast of England, rises to the height of seven or eight fathoms; but at Annapolis, in the Bay of Fundy, (where the bore also is tremendous,) the water sometimes rises above 100 feet. Inland seas, whose entrances face the west, have rarely any tides, because the moon acts on all their parts at once, and there are no lateral waters to flow in and produce a local elevation.

The regular period of flux and reflux is 12 hours 50½ minutes, so that the tides return later and later each day by 50½ minutes, which is the excess of a lunar day over a solar one, since 28½ lunar days are nearly equal to 29½ solar ones.

Straits and Castle of Dover.

According to Buache, the Straits of Dover are on an average less than 30 fathoms deep, and from thence westward to the chops of the Channel the water gradually deepens to 420 feet.

The hill on which Dover Castle stands is, at the highest part near the turnpike, 390 feet high. The cliff, where the castle-wall terminates, is about 340 feet high. About a mile north of Folkestone is the highest point in the range of Dover hills, being 575 feet above the sea.

Lakes and Rivers.

All large lakes without an outlet, such as the Caspian Sea, have salt water. The deepest part of the Lake of Geneva is between Vevay and Rolle, where it is 164 fathoms; its height above the level of the Mediterranean, 1126 feet (French). In August, 1806, the water of the Hawkesbury river, in New Holland, rose 86 feet beyond the usual level; in 1816, the same river rose 84 feet.

The entire length of the river Mississippi is 3038 miles.

The Ganges, reckoning its sinuosities, has only a fall of four inches per mile.

The Thames Water.

The Thames opposite to London Dock gate was found by Mr. Stevenson to be perfectly fresh. At Blackwall, even in spring-tides, the water was found to be only slightly saline; at Woolwich the proportion of salt water increases, and so on to Gravesend. The strata of salt and fresh water were found to be very imperfectly marked, probably on account of the slowness of the current. From a series of observations made at and below London-bridge, compared

with the river as far up as Kew and Oxford, Mr. Stevenson is of opinion, that the waters of the Thames seldom change, being probably carried up and down with the turn of the tides for an indefinite period of time, to which circumstance he is inclined to attribute the extreme softness of the Thames water.

In the river Dee, the salt water, when the tide is flowing, insinuates itself under the fresh water of the descending current, so that the river is fairly lifted upwards.

Length of Rivers.

Taking the river Thames from its source to the estuary as the unit, the proportional lengths of the other rivers are estimated by Major Rennel as follows:

Thames	1	Jenesia	10
Rhine	$5\frac{1}{4}$	Oby	$10\frac{1}{2}$
Danube	7	Amour	11
Volga	$9\frac{1}{2}$	Lena	$11\frac{1}{2}$
Indus	$5\frac{1}{4}$*	Hoanho	$13\frac{1}{2}$
Euphrates	$8\frac{1}{2}$	Kian Kew	$15\frac{1}{2}$
Ganges	$9\frac{1}{2}$	Nile	$12\frac{1}{2}$
Brahmaputra	$9\frac{1}{2}$	Mississippi	8
Ava River	$9\frac{1}{2}$	Amazons	$15\frac{1}{4}$

If the length of the Thames, including its windings, be reckoned equal to 300 miles, which is not far from the truth, the length of the others may be calculated.

* Since the above computation was made, the course of the Indus has been found fully equal in length to that of the Ganges; the Nile is also under-rated, and the Missouri was then unexplored. Probably the course of the latter river, from its source to where it joins the ocean under the name of the "Mississippi," is the longest in the world.

Coral Islands.

The coral-making animals do not commence their labours at the extreme depth of the ocean, but on rocky shoals, the summits of submarine mountains, round which they form a united chain, irregular in shape, but generally approaching more or less to a circle. The outer ledge of the reef exposed to the surf of the sea, is the first that shows itself above water; in process of time it becomes indurated, breaks and crumbles by the action of the sea, and at length forms a barrier, within the sloping sides of which the living animals are seen carrying on their operations. Those observed by Chamiso (the naturalist with Lieut. Kotzebue,) were the tubipora musica, millepora, cælurea, obstichopora, and various kinds of polypi. As soon as the ledge has reached such a height that it remains almost dry at low-water, the coral insects leave off building any higher.

Coral reefs rise almost perpendicularly on the windward side, sometimes from the depth of 200 fathoms.

Two Latitudes.

Strictly speaking, we have now two latitudes to the same place; one that determined by astronomical observation at the surface of the earth, and the other the latitude corrected for the earth's ellipticity, and known by the appropriate name of Geocentric.

Mercator's Chart.

In Mercator's Chart, or projection, there are none but right lines; all the meridians are equidistant; but in order to obtain the true bearing by the compass, the spaces between the parallels of latitude are made to increase as they recede from the equator, so that in high latitudes they become prodigiously great.

The peculiar advantages of this projection are,

that every place retains its true bearing, with respect to all other places; the distances may be measured with the nicest exactness, and all the lines are right lines. For these reasons, it is the usual projection in drawing maps and charts for the use of navigators. Its only disadvantage is, that the countries situated in high latitudes are of necessity increased beyond their just size to a monstrous degree.

Mountains.

	Feet.
Height of the highest peak of the Rocky Mountains in North America . . .	11,500
Ditto of Sukanda in the Himalaya . . .	25,589
Ditto of Chimborazo in the Andes . . .	20,571
Ditto of Dhawalagiri in the Himalaya . .	27,000

British and Irish Mountains.

	Feet.
Wharnside in Yorkshire, the most elevated mountain in England, is in height . .	3840
Ingleborough ditto	3700
Benevish in Perthshire, the highest in Scotland	4370
Magillicuddy's Reeks at Killarney, the highest in Ireland	3695
Stubh Donard, in the county of Down . .	2809
Snowden	3568
Cader Idris	3550
Crossfell	3390
Penmaenmawr	1400
Malvern hills (the beacon)	1300
Goatfield, in Arran	2945
Benlomond	3260
Snawfel in the Isle of Man	1740
Arthur's Seat	810
Salisbury Craigs	550
Calton Hill	350

Levels in London.

	Above the highest water mark. Ft.	Inch.
North end of Northumberland street, Strand	19	7
Ditto of Wellington street, Strand .	35	6
West end of Coventry street . . .	52	0
South end of St. James's street . .	13	3
North end of ditto	46	7
North end of Drury lane	65	0
North end of Regent street	76	0
Centre of Regent circus	77	0
North end of Cleveland street . . .	80	10

The whole of Westminster, except the Abbey and part of Horseferry road, is below the level of the highest tide.

The breadth of the Thames at Westminster-bridge is about 400 yards.

Square Miles.

To convert the English square mile into a measure applicable to the maps of all civilized nations, it is only necessary to reckon it as $\frac{3}{4}$ths of the area of the square geographical mile; in other words, that four English square miles are equal to three geographical.

Temperature of the North Pole.

Dr. Brewster estimates the mean temperature of the north pole at about 11° Fahrenheit, which is incomparably warmer than Melville island in lat. 75°, where the mean temperature was found to be minus 2°, or two degrees of Fahrenheit below the freezing point. It is probable, therefore, that the north pole of the globe is not the coldest point of the arctic hemisphere, but that there are two points of greatest

cold about lat. 80° N., and 95 E. and 100 W. long., possibly coinciding with the two magnetic poles.

In Peru, the line of perpetual snow is about 14,000 feet above the level of the sea.

Dryness of High Latitudes.

So small is the quantity of moisture in the atmosphere of high latitudes, that it scarcely ever rains. No snow fell at Melville island during a whole winter, and the spiculæ that floated in the air, lay on the ground not more than a few inches deep.

The North Pole.

An author of reputation says, "We verily believe that, at the pole itself, neither wind, tide, snow, thunder, or lightning, will be found to exist, or if any, in the smallest possible degree."

POPULATION, &c.

THE state of a country with regard to numbers of people.

Census of 1801.

Population of Great Britain according to the census of 1801 :

	Males.	Females.
In England	3,987,935	4,343,949
Wales	257,178	284,368
	4,245,113	4,628,317
Scotland	731,581	864,487
	4,979,694	5,492,804
Army, including militia . .	198,351	
Navy, including marines .	126,279	
Seamen, in registered ships .	144,558	
Convicts, in hulks . . .	1,410	
	5,450,292	
Add Females . .	5,492,646	
	10,942,646	
Isle of Man, Guernsey, Jersey, &c., by estimate .	80,000	
Ireland, as ascertained by hearth-money . . .	4,000,000	
Grand Total . . .	15,022,646	

Census of 1801, 1811, *and* 1821.

	1801.	1811.	1821.
England . .	8,331,434	9,538,827	11,261,437
Wales . .	541,546	611,788	717,438
Scotland . .	1,599,068	1,805,688	2,093,456
	10,472,049	11,956,303	14,072,331
Army, Navy, &c.	470,598	640,500	319,300
Totals . .	10,942,646	12,596,803	14,391,631

Guernsey and the adjacent isles . .	20,827
Jersey	28,600
Isle of Man	40,081
Total . .	89,508

1821.	Males . .	7,137,018
	Females . .	7,254,613
	Total . .	14,391,631

England during the last Century.

Table of the population throughout the last century:*

A.D.	1700 .	5,475,000	A.D.	1760 .	6,736,000
	1710 .	5,240,000		1770 .	7,428,000
	1720 .	5,565,000		1780 .	7,953,000
	1730 .	5,796,000		1790 .	8,675,000
	1740 .	6,064,000		1801 .	9,168,000
	1750 .	6,467,000			

* The early estimates of the population are evidently mere guesses.

London.

The population of London A.D.	1700.	1750.	1801.	1810.	1821.
City of London within the walls . . .	139,300	87,000	78,000	57,704	58,400
City of London without the walls . .	69,000	57,300	56,300	68,000	72,000
City and liberties of Westminster . .	130,000	152,000	165,000	168,600	189,000
Out parishes within the bills of mortality	326,900	357,600	477,700	593,700	730,000
Parishes not within the bills of mortality	9,150	22,350	123,000	162,000	224,300
Total of London	674,350	676,250	900,000	1,050,000	1,274,800*

In 1821 the total population of all the parishes, whose churches are situated within eight miles rectilinear around St. Paul's cathedral, was 1,481,500; the parish of Woolwich not included.

N.B. The population ascribed to the city of Paris is included in a district of this size.

In A.D. 1700, London contained $\frac{1}{8}$th, in 1750 above $\frac{1}{10}$th, and in 1801 rather less than $\frac{1}{10}$th, of the whole population of England and Wales.

In 1810, the number of houses in and near to London was 245,005.

In 1821, the total number of inhabited houses in England was .	1,951,973	
uninhabited ditto	66,055	
		2,018,028
In Wales, inhabited houses	136,183	
uninhabited ditto	3,632	
		139,835
Total		2,157,863

* This includes the floating and fluctuating population of seamen, &c. estimated at $\frac{1}{25}$th of the whole.

Principal Towns of England.

Population of some of the principal towns, according to the census of A.D. 1801, A.D. 1811, A.D. 1821.

London . . .	864,845	1,009,546	1,274,800
Manchester . .	84,020	98,573	133,788
Liverpool . . .	77,653	94,376	118,972*
Birmingham . .	73,670	85.753	106,722
Bristol	68,645	76,433	87,779
Leeds	53,162	62,534	83,796
Plymouth . . .	43,143	56,000	61,212
Newcastle . . .	——	——	35,181
Norwich . . .	36,684	37,256	50,288
Bath	32,200	31,496	36,811
Portsmouth . .	32,166	40,467	45,648
Sheffield . . .	31,314	35,840	42,157
Hull	29,516	——	31,425
Nottingham . .	28,861	34,253	40,415
Exeter	17,398	——	23,479
Leicester . . .	16,953	——	30,125
York	16,145	——	20,787

* Notwithstanding all the pains taken to procure correct returns, these numbers convey no just notion of the real population of the different towns. Liverpool, for instance, is much underrated, and some others probably as much exaggerated. The sum total here given (118,972) is only that of the *parish and borough of Liverpool*, excluding every thing beyond their strict limits, although some of the houses are so constructed, and the line so continuous, that one portion is within the borough of Liverpool, and the other without; from which it results, that a male child born in one room is a freeman, and in another an alien. Besides this, the floating population of seamen, &c. is wholly omitted, whereas, in the returns for London, they are calculated at $\frac{1}{25}$th. The real population of Liverpool exceeds the following estimate:

Population of the parish and borough of Liverpool,	118,972
Ditto of Toxteth Park	12,829
Ditto of Everton	2,109
Ditto of Kirkdale	1,273
Ditto of the floating population of seamen, &c. as in the estimate of London, $\frac{1}{25}$th .	5,400
Grand Total . .	140,583

Principal Towns of Scotland.

	A.D. 1801.	1810.	1821.
Edinburgh . . 67,288			
Leith . . 15,272			
	82,560	102,987	138,235
Glasgow	77,385	110,008	147,043
Paisley	31,179	36,722	38,048
Aberdeen burgh & parish	——	33,870	44,796
Dundee burgh and parish	——	29,616	30,575
Greenock	17,458	19,052	22,088
Perth	14,878	16,948	19,068
Dumfermline burgh and parish	——	11,649	13,681
Inverness burgh & parish	——	10,757	12,264
Kilmarnock town and parish	——	10,148	12,769
Dumfries burg and parish	7,283	——	11,052

Principal Cities of Ireland.

Dublin	186,276
Cork	100,535
Limerick	66,042
Galway	27,827
Waterford	26,787
Kilkenny	23,230
Drogheda	18,118*

Manchester, in reality, contains 149,756 inhabitants; for the townships of Ardwick, Charlton Row, and Hulme, not included above, are now constituent portions of the actual town. Some other towns, especially in Scotland, seem to have limits of a wonderful elasticity.

* The population of Belfast, and some other considerable towns, has not been procured.

Rank of the Principal Towns in Great Britain and Ireland, with respect to Population, in 1821.

London	1,274,800
Dublin	186,276
Glasgow	147,043
Edinburgh	138,235
Manchester . . .	133,788
Liverpool	118,972
Birmingham . . .	106,722
Cork	100,535

Population of Ireland, A.D. 1821.

Connaught . . .	1,053,918
Leinster	1,785,702
Munster	2,005,363
Ulster	2,001,966
Total . .	6,846,949

Principal Towns of the United States.

Population of some of the principal towns according to the census of 1810:

New York . .	96,373	New Orleans	17,242
Philadelphia .	75,096	Salem. . . .	12,613
Baltimore . .	35,583	Providence .	10,071
Boston . . .	33,250	Washington county .	18,750
Charleston . .	24,711		

Food and Population.

Food increases in an arithmetical ratio; population, according to a geometrical ratio; viz.

Food as . 1—2—3—4—5—6—7—8—9, &c.
Population 1—2—4—8—16—32—64—128—256, &c.

All animals, according to known laws, must have a capacity to increase in a geometrical progression: the question with regard to man is, at what rate does this geometrical increase proceed?

Nothing but the confusion and indistinctness arising

from the largeness of the subject, and the vague and false notions that prevail with respect to the efficacy of emigration, could make persons doubt the soundness of the principle.

Checks to Population.

These are resolvable into moral restraint, vice, and misery.

Moral restraint.—Abstinence from marriage and a strictly moral conduct towards the sex in the interval. All other checks resolve themselves into some form of vice or misery.

The distress from a redundant population is brought home to the feelings of the higher classes by the difficulty which they find in supporting their families in the same rank of life with themselves.

Unceasing increase is evidently inconsistent with limited space.

Rome.

Gibbon estimated the population of Rome, in the time of Trajan, at 1,118,000 souls.

Paris.

In A. D. 1816, the annual food of each inhabitant of Paris was 693 pounds English; of which vegetable food, &c. was 469, and animal food, comprehending meat, fish, butter, eggs, fruit, and garden esculents of all sorts, 224 lbs. English.

Old Countries.

No application of knowledge or ingenuity, no efforts either of the rich or poor, or both in the form of contributions, or in any other way, can possibly place the labouring classes of society in such a state as to enable them to marry generally at the same age, in an old and fully-peopled country like England, as they may do with perfect safety and advantage in a new one.

Kindred.

If we suppose each couple of our ancestors to have left, one with another, two children, and each of these children, on an average, to have left two more, (and without such a supposition the human species must be daily diminishing,) we shall find that all of us have now subsisting near two hundred and seventy millions (270,000,000) of kindred in the fifteenth degree.

Power of Increase.

The power of increase in plants and animals is prodigious. In the Philosophical Transactions for 1768, an account is given of an experiment, in which, by separating the roots obtained from a single grain of wheat, and transplanting them in a favourable soil, a return was obtained of above 500,000 grains. The whole world might be covered with sheep in less than a century.

It is to the ignorance and bad government of our ancestors that we are indebted for the comparative facility which we now enjoy of procuring subsistence;* had it been otherwise, the population that would have accumulated since the reign of William the Conqueror, must have overflowed like the swarming of the northern hives during the fall of the Roman empire.

Population of the United States.

The censuses of 1800, 1810, and 1820, furnish

* An entertaining writer says, "If all the Turks and Egyptians that are to die next year of the plague, were to be devoured during the present by crocodiles, a certain quantity of food would be gained, and things go on just as before. The Roman empire, and the world generally, would have been equally populous and prosperous, if the Huns and Ostrogoths had eaten each other, instead of strewing their own bones and those of their antagonists through the wilds of Dacia, and along the banks of the Danube.

primâ facie evidence that the population of the United States has for a considerable time been going on doubling itself in 25 years.

The emigration to the United States from Europe, for the last 25 years, falls decidedly short of 10,000 persons per annum.

Censuses.

When a census is taken every ten years, all above ten years, exclusive of emigrants, must have existed in the census immediately preceding; and consequently, after having made a proper allowance for the mortality during these ten years, the excess above the remaining number must be attributed to emigration.

If we had the means of estimating with accuracy the loss which would be sustained in America, by a population not increased by additional births, this mode of estimating the amount of emigration would be unobjectionable, and often very useful; but, unfortunately, the means are deficient, for even the annual mortality in the United States is not known.

On account of the number of males absent from home, it has been proposed to estimate the increase of population by the females only.

Mortality.

A mortality of about 1 in 20 would probably keep the births on a level with the deaths, though all married at twenty years of age.

The annual mortality in England is about 1 in 58.

The Cape of Good Hope.

The total population of the Cape of Good Hope, in 1821, was as follows:—

Males	24,977
Females	23,001

Hottentots	Males . . .	14,291
	Females . . .	14,544
Apprentices	Males	918
	Females . . .	451
Slaves	Males	19,164
	Females . . .	13,024
	Total	110,370

But including the garrison, and 3533 new settlers, the total population, in 1822, was about 120,000 souls.

Indian Population of Spanish America.

M. de Humboldt disputes the assumed fact of the destruction or diminution of the Indians in the Spanish American colonies. There still exists, he says, in the two Americas, a coloured population of six millions; and although a great many tribes and languages have been extinguished or confounded, the total number of Indians has not greatly diminished since the discovery of America.

Brazil Population, 1820.

3-5ths Negroes and their descendants	1,800,000
1-5th Whites, Creoles, &c. . . .	600,000
1-5th Indians	600,000
	3,000,000

City of Rio de Janeiro, 135,000, including 105,000 Negroes.

Buenos Ayres, 1820.

Population of the provinces of Rio de la Plata, consisting of Buenos Ayres, Santa Fe, Entre Rios, Cordova, Mendoza, St. Juan, Punta de St. Luis, St. Jago del Estevo, Tucuman, and Salta, 457,000 souls.
City of Buenos Ayres, 60,000.

Chili, 1820.

Comprehending the three divisions or provinces of Coquimbo, St. Jago, and Conception, 600,000 souls.
City of St. Jago, 48,000.

Peru, 1820.

Total population, including 800,000 Indians, 1,400,000 souls.
City of Lima, 70,000, including slaves, mulattoes, &c.

Bengal.

The East India Company's old territory, commonly known in Europe by the name of Bengal, occupying the space of 162,000 square British miles, contained, in 1820, thirty-nine millions six hundred and seventy-nine thousand souls, (39,679,000 souls,) exhibiting a denser population* than any equal portion of the globe, China not excepted.

* Yet, according to some authors, this country has for the last sixty years been misgoverned to a proverb.

CHEMISTRY.

CHYMISTRY.—Philosophy by Fire. (Johnson from Arbuthnot.)

Various Definitions of Chemistry.

1. The study of effects produced by heat and mixture.

2. The study of the effects of heat and mixture, with the view of discovering their laws.

3. The science which teaches the knowledge of the intimate and reciprocal action of bodies on one another.

4. The phenomena resulting from the operation of attractions and repulsions at insensible distances, constitute the proper objects of chemical investigation.*

The Chemistry of Nature.

The art of man does nothing more than bring things nearer to one another, or carry them further off; the rest is performed by nature, and generally by means of which we are ignorant.

Operating Causes.

From the exertion of two powers, *heat and contiguous attraction*, arise the actions which are arranged under the science of chemistry.

* No definition of this science has yet been invented of such logical precision as to be entirely free from objection; partly owing to its being of so comprehensive a nature, that it is impossible to say where it begins, or where it ends.

Elements.

The bodies which we at present call chemical elements are probably all compounds.

Chemical Union.

It has been admitted as an axiom in chemistry, that chemical union consists in the combination of the atoms of bodies with each other.

Modes of Existence.

Solidity, liquidity, and aeriform elasticity, are only three different forms of existence of the same matter.

Discoveries.

Dr. Black discovered carbonic acid and latent heat.

Mr. Cavendish, hydrogen, the composition of water, and nitric acid.

Dr. Priestly, nitrous gas, the existence of ammonia, and several of the acids, in an aerial form, and oxygen gas.

Scheele also discovered oxygen gas, azote, and the composition of atmospheric air.

Lavoisier overturned Stahl's system, and introduced a new theory.

Dalton, the theory of definite proportions.

Sir. H. Davy, the metallic bases of the earths and alkalies.

Chemical Nomenclature.

The new chemical nomenclature (commonly called Lavoisier's) was sketched and delivered to the world in A. D. 1787, by Lavoisier, Fourcroy, Morveau, and Berthollet. The prior chemical nomenclature was founded by Stahl, in 1720, and was adapted to the system of Phlogiston.

Calcination.

It is a general fact observed in nature, that metals are always rendered heavier by calcination.

Dr. Black's Law.

Dr. Black's law is, that whenever a body changes its state, it either combines with caloric, or separates from caloric.

Dalton's Rule of Affinity.

Where two bodies combine in different proportions, if the quantity of one of them be assumed as a fixed number, the proportions of the other body that unites to it are in the simplest possible ratio with each other, being produced by multiplying the lowest proportion by a simple integral number, as 2, 3, 4, &c.

Thus, for example, if a metal can combine chemically with different proportions of oxygen; if 100 of the metal can take nine of oxygen for the lowest degree of oxygenation, all the other degrees will be in the proportion of 100 to twice 9 (18) of oxygen; to three times 9 (27) of oxygen; or 100 of metal to four times 9 (36) of oxygen, and so on.

Simple bodies are disposed to unite atom to atom. Hence, from the relative weights of the constituent parts of a compound, Mr. Dalton infers the relative weights of the ultimate particle or atom of each of the parts; and this being found, the number of atoms of each constituent which enter into the formation of the compound particle is also deduced.

Unity.

The substance of which, as far as we know, the smallest relative weight enters into chemical combination, is hydrogen; on which account the weight of

its atom is assumed as unity, and is the standard of comparison for the relative weight of the atom of all other bodies.

The only compound of hydrogen and oxygen that we are acquainted with is water, in which the oxygen is to the hydrogen as 7 to 1. The number 7 is, therefore, assumed as the relative weight of the atom of oxygen; and water is a binary compound, containing an atom of hydrogen with an atom of oxygen in every atom of water.

Chemical Signs.

○ Represents an atom of oxygen.
⊙ . . . . ditto of hydrogen.
⦶ . . . . ditto of azote.
● . . . . ditto of carbon.

Atomic Theory.

The atomic theory in chemistry supposes that the atoms of bodies unite together; that the atom of each body has a determinate weight, and that this weight regulates the proportion in which bodies combine with each other.

Atoms.

It is the general opinion, that the elements of bodies consist of atoms or extremely minute particles incapable of further division. It is impossible to demonstrate the truth of this opinion, but it has been almost universally admitted since the time of Bacon.

According to the theory of Boscovick, the first elements of atoms of matter are indivisible, unextended, simple, homogeneous, and finite in number. Their actual contact is impossible.

Ultimate Atoms.

Dr. Wollaston came to the conclusion, that the

earth's atmosphere is limited, and consequently that matter has a finite divisibility;* and that the doctrine of ultimate atoms may therefore be considered as established.

Invariable Proportion.

All chemical compounds contain the same constant proportion of constituents with the most rigid accuracy, not the slightest variation ever taking place. This regularity can be ascribed to nothing else than the constant union of one atom of one body with one atom of another; or of a determinate number of atoms of one body, with a determinate number of atoms of another.

Trituration.

Mechanical trituration, however carefully performed, is quite incapable of separating from each other substances that are chemically united.

The Chemico-electric Theory.

Sir Humphrey Davy advanced the opinion, that chemical affinity is identical with electric attraction; that bodies which unite chemically possess different kinds of electricity; that oxygen and acids are always resinous or negative electricity; and earths and metals always vitreous or positive electricity. Hence the reason why one set is attracted by the negative pole, and the other by the positive.

It results from this theory, that bodies remain united because they are in different electric states. If they can be brought into a similar state by making them both positive or both negative, they will repel each other, and of course be decomposed. The galvanic battery produces this effect, if it be sufficiently powerful.

* Yet of the smallest atom we can always imagine the half.

Arrangement of Particles.

The particles of matter can change their arrangement, (as from being flexible to brittle or crystalline,) without losing their solid form.

The Freezing and Boiling Points.

The two unalterable points of temperature are, in the first instance, when ice becomes water, and in the second, when water becomes steam, and have been universally adopted by the various constructors of thermometers for the graduation of those instruments; but the space between them has been differently divided by different persons.

Reaumur divides the space between the two points above mentioned into 80 degrees, placing 0 at freezing, and the 80th degree at the boiling point.

Fahrenheit divides the above space into 180 degrees; but the cypher (0) he places 32 degrees below the freezing point, (the cold of a mixture of snow and common salt,) so that the freezing point is at 32°, and the boiling point at 212°.

Reaumur 80°)180° Fahrenheit.

$2\frac{1}{4}$° of Fahrenheit equal 1° of Reaumur.

Plus 20° of Reaumur is 20° multiplied by $2\frac{1}{4}=45$ add 32°=77° of Fahrenheit.*

By adding salt to water, in a still, its boiling point is raised a few degrees, and the boiling point is lowered in proportion to the elevation above the surface of the earth.

Thermometers.

Spirit of wine thermometers are the best for measuring very low temperatures, as that fluid never freezes; whereas the low temperature at which it

* Or multiply the degrees of Reaumur by 9, divide the product by 4, and add 32°.

boils, renders it unfit for measuring high temperatures. Quicksilver will indicate 500° of heat, but freezes at 40° below the freezing point.

Wedgewood's Pyrometer.

In Wedgewood's Pyrometer, the zero corresponds with 1077° of Fahrenheit, each degree being equal to 130° Fahrenheit.

Combustion.

Combustion is the result of intense chemical action, the cause of which has not yet been discovered.

Combustion, in common cases, is the solution of a body in oxygen or the fixation of oxygen in a solid form, or the production of a fluid when oxygen and hydrogen unite.

Inflammable and Combustible.

These are not synonymous terms. All metals are combustible, that is, capable of uniting with oxygen; but they will not burn in atmospheric air, and are therefore not called inflammable.

Pure Flame.

Hydrogen gas furnishes the purest flame that can be exhibited; for the flame of bodies that emit much light derives that power from solid bodies intensely ignited, and diffused through them, and which in ordinary flames, as of gas, tallow, wax, oil, &c. consists of finely divided charcoal.

Oil and Coal Gas.

Gas from oil or coal, freed from all impurities, is a mixture of olefiant gas, carburetted hydrogen, hydrogen, carbonic oxide, and azote, with an essential oil held in solution. Oil gas is free from sulphuretted hydrogen, which renders the coal gas so injurious to silver and plated goods.

At Edinburgh, coal gas is manufactured at a total expense of 8*s*. per 1000 cubic feet, and sold for 12*s*.; oil gas costs 26*s*. per 1000 cubic feet in manufacturing, valuing the oil at 2*s*. per gallon, but it has almost double the illuminating power of coal gas.

In 1824, the extent of gas-pipe in and about London exceeded 900 miles.

Latent Heat.

Let one pound of ice at 32° be dissolved in one pound of water at 172°, and it will be found that 140° of heat have disappeared and become latent in the fluid, which assumes the temperature of 32° only.

On the other hand, if a pound of water at 172° be mixed with a pound of ice-cold water at 32°, the temperature of the mixture will be exactly 102°, which is the mean of $32+172°$ or 204°.

It requires 140 degrees of heat to give it fluidity, which it receives without the least augmentation of temperature perceptible by the thermometer.

The fire produced by flint and steel is caused by the sudden extrication of the latent caloric.

Solar and Terrestrial Heat.

It has been conjectured, that there is a difference between solar and terrestrial heat, the rays of the first passing through glass without heating it, while the rays of the latter are stopped by the glass, which becomes hot when opposed to them.

Animal Heat.

It is probable that all organized beings, vegetable as well as animal, possess an inherent power of generating cold or heat according to circumstances.

Extreme Heat of the Air.

We may conclude, from some experiments of

Humboldt's, that the air of the atmosphere, although perfectly stagnant, could in no possible circumstances be heated above 140°, and this only within three feet of the ground. On the west coast of Africa, the thermometer is said to rise to 130° in the sun; a thermometer placed in the sand at Magpures, rose to 140° Fahrenheit.

Another author says, that at no place of the earth's surface, nor at any season, will a thermometer, raised two or three yards above the soil and sheltered from reverberation, attain 115° Fahrenheit, nor on the open sea, in any circumstances, reach 88° Fahr.

Solidification and Liquefaction.

When water is poured on quick-lime, a great degree of heat is produced by the solidification that takes place. Congelation, therefore, to surrounding bodies is a heating process, and liquefaction a cooling one.

Compression.

In gases expansion produces cold, and compression heat. A sudden compression of air produces heat enough to inflame tinder.*

Latent Heat of Steam.

The latent heat of steam is somewhere between 900° and 1000° of Fahrenheit.

When, therefore, it is again condensed into water, the latent heat becomes sensible; the consequence of which is, that a small quantity of steam will, during

* Take a small tube, either of glass or metal, about three-eighths of an inch in diameter, and four inches long, securely stopped at one extremity. Fix a bit of dried fungus to the end of the rammer, then thrust it smartly down the tube, and the heat of the compressed air therein contained will cause the fungus to ignite.

its condensation, communicate heat sufficient to boil a large quantity of water.

A given quantity of steam will produce, by its condensation, a much greater elevation of temperature, than the same quantity of boiling water.

Boiled Potatoes.

One per cent. to the bulk of water is put into the boiler of the steam-engine, to prevent the cohesion of the precipitated calcareous salts, (selenite or carbonate of lime). The boiler is emptied once a month, and new potatoes added. This has been long practised in England, but only recently in France.

Heat.

Nothing is known of the nature of heat, or of caloric, its cause. Count Rumford has clearly proved that it has no weight. A phial of spirits of wine and one of water remained in equilibrium after the latter was frozen, although it thereby lost as much caloric as would have brought to a white heat the same weight of gold.

It is generally admitted, that the atoms of caloric are attracted by every other substance, while they mutually repel each other.

Friction.

Sir H. Davy melted two pieces of ice by their mutual friction, in a room cooled below the freezing temperature.

Newton's Subtle Fluid.

That a subtle fluid existed, and was diffused through those spaces from which air was exhausted, appeared evident to Sir Isaac Newton, from many

considerations, and particularly from this, that a thermometer placed in vacuo will grow warm almost as soon as one not in vacuo.

Extreme Tenuity.

The thinnest substance ever observed is the aqueous film of the soap bubble previous to its bursting; yet it is capable of reflecting a faint image of a candle or of the sun. Hence its thickness must correspond with what Sir Isaac Newton calls the *beginning of black*, which appears in water at a thickness of the $\frac{1}{750000}$th part of an inch.

Reflected Heat.

Buffon kindled wood by reflection from mirrors, at the distance of 210 feet.

A drop of water rolls about on a red-hot iron without evaporation, because its surface becomes so highly polished as to reflect all the heat. If the heat be less, the water penetrates the pores of the oxidated iron, and losing its polish, is evaporated.

Heat Conductors.

When different bodies are exposed to the same source of heat, they suffer it to pass through them with different degrees of velocity; or, they have various conducting powers with regard to heat. Good conductors, when touched, occasion a greater sensation of heat and cold than bad ones.

When the body feels cold, the caloric is passing out of it into the neighbouring object; when the body feels warm, it is receiving heat.

Motes in the Sun-beam.

If the temperature of a metallic stove for heating a room be raised much higher than 300° Fahrenheit, the animal and vegetable matter, which is found me-

chanically mixed at all times with the air, will be decomposed, and certain elastic vapours and fluids produced, of a deleterious quality, and peculiar smell. The matter here alluded to is very visible to the naked eye in a sun-beam let into a dark room.

Crucibles.

The most refractory of all crucibles are those made entirely of clay, coarsely powdered, burned clay being used as a substitute for sand. Such a compound resists the action of saline fluxes longer than any other, and is therefore used for the pots of glass furnaces.

Smoke-devouring Furnaces.

The improved method of constructing furnaces consists in causing the smoke or flame of fresh fuel, on its way to the chimneys, to pass through, over, or among fuel, which, having already been converted into coke or charcoal, had ceased to smoke, by which expedient the grosser parts of the flame or smoke are consumed, or converted into pure flame free from smoke.

Diurnal Heat.

The hottest time of the day is generally about two o'clock in the afternoon, and the coldest just before sunrise. In this climate the daily heat may be reckoned from that of eight o'clock in the morning; and the month of October is found to have nearly the mean temperature of the whole year.

Cooling.

The process of cooling is much retarded by surrounding the heated vessel (suppose a tea-pot) at the distance of nearly an inch, with a case of planished tin; and the addition of other cases, following

it at like distances, continually augments the effect. With an obstruction of one case, the rate of refrigeration is three times slower; with two cases, it is five times slower; with three cases, seven times slower; and so on as expressed by the succession of odd numbers.

Concentrated Cold.

A piece of frozen quicksilver the size of a walnut, dropped into a tumbler of warm water, occasions its instant congelation, accompanied with the fracture of the glass.

Artificial Cold.

The greatest artificial cold that has yet been produced, was effected by the mixture of diluted sulphuric acid with snow, which sunk Fahrenheit's thermometer to minus 91°, or 123° below the freezing point.

Bengal Ice.

From experiments in procuring ice, Dr. Wells found reasons for inferring, that water may freeze at night in air of a temperature higher than 32°, without any loss from evaporation; and he concludes, that the formation of ice in Bengal must be attributed to a loss of heat which the water suffers by its own radiation, and not from evaporation.

Latitude and Elevation.

A degree of latitude, in France, may be reckoned as affecting the mean temperature, nearly in the proportion of 180 and 200 yards of elevation.

Perpetual Congelation.

The never-melting snows begin under the equator at 2460 fathoms above the level of the sea; under the 20th degree north or south latitude, at 2350;

under the 45th, at 1300; and under the 62d degree, at 900 fathoms above the level of the sea.*

Polarized Light.

When polarized light is transmitted through rock crystal, it is depolarized, or converted into common light.

Under certain circumstances light can penetrate through glass when in one position, but not in another.

Phosphorescence.

Bodies which become luminous without undergoing combustion, are said to be phosphorescent.

Solar phosphori become luminous when removed into a dark room, after having been exposed to sunshine.

Some are spontaneously phosphorescent, such as the flesh of salt-water fish just before it putrifies, and also decayed wood.

When fish putrify, the light is not occasioned by the flesh of the animal, but by numerous animalculæ, whose growth the putrefaction has promoted.

The minute species of medusa are very common in the sea, and produce those sparks and globes of light constituting the luminousness and phosphorescence of the sea, so visible during a dark night in the wake of a ship, or when the water has been struck by an oar.

* Such are the ratios, according to theory, but they have not been found to correspond practically at these elevations on the Himalaya mountains. Lieut. Gerard says, "The highest vegetation we saw was a plant with the leaves like sage, but without smell, and brown from the dryness of the atmosphere. It grows at the height of 17,000 feet, beyond which we found no soil." According to theory, the boundary of congelation traverses the parallel of latitude 30 degrees, (that of the Himalaya,) at the altitude of 11,484 feet.

Light and Motion.

It is known by experiment, that every sudden stroke, every rapid motion, impressed on a mass of air which cannot yield with sufficient quickness, excites in it a degree of light.

Gas.

This term is applied to all permanently elastic fluids of an aerial form, except common atmospheric air.

Weight of the Gases, &c.

100 cubic inches	of	oxygen, weigh .	33·75 grains.
Ditto	ditto	chlorine . . .	75·375
Ditto	ditto	iodine (vapour of)	264·937
Ditto	ditto	hydrogen . . .	2·25
Ditto	ditto	steam	18·80
Ditto	ditto	nitrogen or azote	29·25
Ditto	ditto	common air . .	30·20
Ditto	ditto	carbonic acid . .	46·575
Ditto	ditto	carburetted hydrogen	30·15
Ditto	ditto	cyanogen . . .	54·9

Liquefaction of Gases by High Pressure.

Mr. Faraday, by high pressure, produced quantities of liquid carbonic acid. In this experiment glass tubes 8 inches long, and $\frac{3}{10}$ths of an inch internal diameter, had a pressure on their internal surface of 8000 pounds weight, without injuring or breaking the glass.

Mr. Perkins's most remarkable result is, the liquefaction of atmosphere under a pressure of 1200 atmospheres.

It is probable that, in the course of time, the liquids resulting from the condensation of the gases will be applied as mechanical agents.

Hydrogen.

The generator of water, which consists of 11·75 by weight of hydrogen, and 88·23 of oxygen. It was formerly named inflammable gas. It extinguishes combustion, and is the lightest ponderable matter known. It is in consequence assumed as unity in describing the specific gravity of gases, and the proportions in which they combine.

Mr. Dobreiner considers hydrogen gas as a metal dissolved in caloric.

Elements and Weight of Water.

Oxygen and hydrogen have never been made to unite in any other proportion than that in which they exist in water, which is 1 part, by weight, of hydrogen, and 7½ of oxygen.

A cubic foot of pure water is found at a given temperature to weigh 1000 ounces avoirdupois.

Water attains its maximum density at the temperature of 42°·3 Fahrenheit.

Oxygen.

The generator of acid: thus named because it communicates acidity to whatever it combines with, and it is never found but in combination. It forms the respirable portion (⅕th) of the atmosphere, and is a principal constituent (88 per cent.) of water, and of most acids and metallic oxides.

To procure pure oxygen from the air, quicksilver may be heated in it at about 600°, until it becomes a red powder, which powder, when ignited, will be restored to the state of quicksilver by giving out oxygen.

The Acidifying Principle.

Oxygen was raised by Lavoisier to a high rank among chemical substances. He considered it as the acidifying principle, as the only supporter of combustion, and capable of uniting with and modifying all other simple bodies. Modern discoveries, however, have considerably lowered the importance of oxygen.

Sir Humphrey Davy has shown, that it forms alkalies as well as acids, and that many acids exist which contain no oxygen, yet they perform all the functions of acids. It is consequently not the acidifying principle, although that doctrine was always maintained by Berthollet. Oxygen has also lost its character of being the only simple supporter of combustion, for chlorine likewise possesses that property, and perhaps in a higher degree than oxygen, with this curious exception, that charcoal will not burn in it, or unite with it.

The Principle of Combustion.

After the discovery of oxygen gas, it was adopted by Lavoisier as the only supporter of combustion. The basis of the gas was supposed to unite with the combustible, and the heat and light which it before contained in the gazeous state were said to be evolved in the form of flame. But in this case several requisites are not fulfilled.

The light depends on the combustible, and not on the quantity of oxygen consumed; besides which, there are very numerous instances of combustion in which the oxygen, instead of being solidified, becomes gazeous during the operation; and lastly, in other instances no oxygen whatever is present.

Combustion, therefore, cannot be considered as

dependent on any peculiar principle or form of matter; but must be regarded as the general result of intense chemical action.

Ultimate Atoms of Oxygen.

Oxygen, being a permanently elastic fluid, must consist of atoms that repel each other; hence, a compound atom of oxygen, or a number of atoms united together, seems quite impossible.

Chlorine.

A permanently elastic gazeous fluid, the oxymuriatic gas of former chemists. It is not respirable, but supports combustion, although it contains no oxygen. It is best procured from a mixture of sulphuric acid, salt, and manganese.

Chlorine was discovered by Scheele in 1774, and by him named dephlogisticated muriatic acid, (muriatic acid deprived of its hydrogen). The term oxymuriatic acid was afterwards applied by the French chemists. It is a permanently elastic gazeous fluid, and is highly injurious when respired, even largely diluted with atmospheric air. Its colour is greenish yellow, whence its name. Phosphorus and some of the metals are spontaneously ignited by chlorine. The compound results of some, possess acid properties; others are not acid. The compounds formed with chlorine are termed chlorides. It is characterized by the property of destroying every vegetable colour with which it comes in contact.

The Bleaching Liquid.

For the generation of chlorine, manufacturers of bleaching liquid usually mix 10 cwt. of salt with from 10 to 14 cwt. of manganese, to which mixture, after its introduction into the alembic, from 12 to 14 of

sulphuric acid are added in successive portions. At the ordinary rate of working, four days are required to make good marketable bleaching powder.

Nitrogen or Azote.

A body which unites with oxygen in five proportions, and in which every additional proportion is a multiple of the first. Thus:

			Nitn.		Oxn.	
1 + 1	. or .		14	+	8	Nitrous oxide.
1 + 2	. or .		14	+	16	Nitric oxide.
1 + 3	. or .		14	+	24	Sub-nitrous acid.
1 + 4	. or .		14	+	32	Nitrous acid.
1 + 5	. or .		14	+	40	Nitric acid.

Muriatic Acid.

This is a compound of chlorine and hydrogen, and is obtained by distilling common salt with sulphuric acid. It is the spirit of salt of commerce. Recent discoveries tend to prove that the alkaline muriates are chlorides, and not muriates.

When it is mixed with nitric acid, the compound acquires the power of readily dissolving gold, which neither of the acids possess separately.

Carbonic Acid.

A gazeous compound of carbon and oxygen; the fixed air of Dr. Black, and mephitic air of older chemists. It is produced by the combustion of the diamond (which is pure charcoal) or pure charcoal. It is thus named because it is identical with the result of the combustion of charcoal in oxygen. Carbonic acid is not above $\frac{1}{600}$th to $\frac{1}{500}$th of the atmospheric air.

Living bodies produce an excess of carbon, and the presence of the oxygen gas of the atmosphere is

required to convert this carbon into carbonic acid. The azotic gas of the atmosphere does not appear to exert any positive influence on living bodies.

Limestone is a combination of carbonic acid and lime.

The Nourishment of Plants.

Carbonic acid gas is formed during fermentation, combustion, respiration, and a variety of other operations, taking place at the surface of the earth, and there has been no process discovered in nature by which it can be destroyed, except vegetation.

The principal consumption of the carbonic acid gas of the atmosphere seems evidently to be in the affording of nourishment to plants.

Hard Water.

Carbonate of lime (common lime) is held in solution by water containing a superabundance of carbonic acid.

Soda Water.

Soda water, prepared in the best manner, ought to contain a very small portion of carbonate of soda, which has a tendency to correct acidity in the stomach. It should also contain about eight times its own bulk of carbonic acid gas, which is generated in the gazometer from chalk and diluted sulphuric acid. Much that is sold under the name of soda water, contains scarcely any soda, being merely water impregnated with carbonic acid gas by means of a forcing pump, and consequently liable to be contaminated by copper, zinc, or lead, according to the vessels in which the condensation is carried on.

A pleasant saline draught is made by dissolving thirty grains of carbonate of soda or potash, and

twenty grains* of citric acid (acid of lemons) in two separate glasses, mixing them, and then drinking them in a state of effervescence.

Cream.

Cream consists of three ingredients: viz.

Butter	. . .	4·5
Cheese	. . .	3·5
Whey	. . .	92·
		100 parts.†

Butter contains from 40 to 65 per cent. of suet.

Oxalic Acid.

The oxalic acid is found in some fruits, and in the juice of the wood sorrel (hence its name) and rhubarb; but it is most readily procured by the action of nitric acid on sugar, and has from this circumstance been termed the acid of sugar.

The Metals.

The metals are forty-two in number, and weigh, compared with water taken as 1; viz.

Platinum . .	21·	Silver . .	10·30
Gold . . .	19·30	Sodium . .	0·972
Mercury . .	13·50	Potassium .	0·865

Platinum is the heaviest body in nature.

The Refining of Metals.

All processes for refining metals by fire must be performed by taking advantage of some property in

* In the sodaic powders of the shops, tartaric acid, on account of its cheapness, is too often substituted.

† Cheese, besides other ingredients, contains a horny substance and the lactic acid; so that with cream to our tea we swallow butter, cheese, suet, whey, lactic acid, and horns.

which the metal operated on may differ from those with which it is alloyed, and from which it is desired to separate it. These differences may consist of the facility or difficulty of oxidation, in their tendency to volatilize, in the temperature required for fusion, and in their relative specific gravities.

Common Salt,

Named also muriate of soda, and chloride of sodium. The waters of the ocean every where abound with it, but in various proportions. All large lakes, such as the Caspian, which have no outlet, have salt water. Common salt, muriate of lime, and other bodies, have not been proved to contain either acid or alkaline matter, and consequently, according to the strict logic of chemistry, ought to be regarded as compounds of chlorine with metals.

Saline Ingredients in Sea Water.

By evaporating a pint of sea water we obtain

Common salt	180·5 grains
Muriate of magnesia	23·
Sulphate of magnesia (Epsom salts)	15·5
Sulphate of lime (gypsum) . . .	7·1
	226·1 grains.

Soda,

Named also mineral alkali, barilla, or kelp. Pure soda is named carbonate of soda. It is the basis of common salt.

The properties of soda are very similar to those of potash, with this remarkable difference, that with soda, oils form a hard soap, while potash forms a soft one. Both are used for the manufacture of soap and glass.

Glauber Salts.

Glauber salts (or sulphate of soda) are obtained by distilling common salt with sulphuric acid: the residue of this operation is Glauber salts. It is named after Glauber, a German, its discoverer.

Epsom Salts.

Epsom salts (or sulphate of magnesia) are usually obtained from the sea water, the residuum of which, after the separation of common salt, is known by the name of bittern, and contains sulphate and muriate of magnesia. It was at one time procured from the springs of Epsom, in Surrey, and whence its name.

Chemical Tests.

Alkalies change the colours of most flowers to green, and acids to red.

Insolubility.

The distinguishing characteristic of all the natural combinations of earths with each other, and with acids, (alum and Epsom salts excepted) is insolubility.

Nitre Beds.

Artificial nitre beds consist of the refuse of vegetable and animal matter undergoing putrefaction, mixed with calcareous and other earths. The air furnishes the oxygen and azote, (or nitrogen,) which are the component parts of nitric acid; but how lime contributes to their union is not known, and the appearance of the potash is equally extraordinary.

Test of Alkali.

The quantity of alkali present in any portion of potash or barilla is directly in proportion to the quantity of acid requisite to produce saturation.

Champagne.

If wine be bottled before the fermentation is completed, part of the sugar remains undecomposed, the fermentation will go on slowly in the bottle, and, on drawing the cork, the wine sparkles in the glass, as, for example, in Champagne.

In Champagne wines the red are generally inferior, because the species of fermentation required to extract the colour, dissipates part of the flavour.

White and Red Wines.

When the must is separated from the husk of the red grape before it is fermented, the wine has little or no colour: such are white wines.

If, on the contrary, the husks are allowed to remain in the must while the fermentation is going on, the alcohol generated dissolves the colouring matter of the husks, and the wine is coloured: such are called red wines.

Hence white wines are often prepared from red grapes, the liquor being drawn off before it has acquired the red colour; for it is only the skin of the grape that gives the colour.

Pure wine is a compound of water, alcohol, acid, colour, vegetable extract, and sugar. The gradual conversion of the ingredient last mentioned, the chief operation that goes on in bottled wines, is the cause of the change that they undergo. Heats and the agitation of a voyage accelerate the imperceptible fermentation, and ripen wines more speedily.

Diluted alcohol, when inclosed in a bladder, becomes greatly concentrated; the watery particles escaping, and the spirit remaining almost pure. It has been suggested to take advantage of this process, by closing the mouths of bottles with bladder instead of cork.

Quantity of Alcohol in Wine.

To ascertain the quantity of alcohol in wine,

Add to one part, by measure, of the wine to be examined, one part of concentrated solution of subacetate of lead; a dense insoluble precipitate will ensue, which is a combination of the test liquor with the colouring, extractive, and acid matter of the wine.

Shake the mixture for a few minutes, pour the whole on a filter, and collect the filtered fluid, which last contains the spirit and the water of the wine, together with a portion of the subacetate of lead.

Add, in small quantities at a time, to this fluid, warm, dry, and pure subcarbonate of potash, which has been previously freed from water by heat, until the last portion thus infused remains undissolved. The alcohol or spirit contained in the fluid will thus be separated; for the subcarbonate of potash abstracts from it the whole of the water with which it was combined; the spirit of the wine forming a distinct stratum, which floats on the aqueous solution of the alkaline salt.

If the experiment be performed in a glass tube, from half an inch to two inches in diameter, and graduated into 100 equal parts, the per centage of the spirit in a given quantity will be at once perceptible, and in this manner the strength of any wine may be examined.

LAW, POLITICS, &c.

Laws must be framed to meet and counteract the vicious propensities of human nature.

It is with laws as with weights and measures, constant attempts at improvement* seem necessary even to prevent deterioration.

Nations must receive not the best laws, but the best laws of which they are capable; and in all legislative enactments, allowances must be made for the natural imbecility and imperfection of every thing that attends human proceedings.

A Court of Law.

In every court of law there must be at least three constituent parts; the actor, reus, and judex. The *actor* or plaintiff, who complains of an injury; the *reus* or defendant, who is called to make satisfaction for it; and the *judex* or judicial power, which is to examine into the truth of the fact, to determine the law arising upon that fact, and if any injury appears to have been done, to ascertain and apply the remedy.

* The grand difficulty is to distinguish what is *improvement*, from what is mere *change* and *innovation*.

Common Law.

This has two different significations; one, proper; the other figurative. In the first it designates that collection of customs made and digested by King Alfred; in its figurative sense we intend those principles of reason, which would govern in the absence of positive authority.

Infraction of Old Rules.

It hath been an ancient observation in the law of England, that whenever a standing rule of law, of which the reason could not be remembered or discerned, hath been wantonly broken in upon by new statutes and resolutions, the wisdom of the rule hath in the end appeared, from the inconveniences that resulted from the innovation.*

Writs.

The names given to the different kinds of writs are usually derived from the first Latin words with which they began when they were written in Latin; or at least from some remarkable word in them. Thus,

A *Pone* is a writ to oblige a person, in certain cases, to give sureties (pone per vadum, and salvos plegios). A writ of *subpœna* is to oblige witnesses, and sometimes other classes of persons, to appear before a court.

An action of *Qui tam* is that which is brought to sue for a proportional share (of a fine established by some penal statute) by the person who laid the information. The words in the writ are Qui tam pro domino rege, quam pro se ipso in hac parte sequitur, &c. &c.

* It is impossible to foresee all the changes on an existing system, which may result from any change.

In a writ of *Latitat*, the person sued is supposed to conceal himself.

Habeas corpus ad subjeciendum is the beginning of a writ.

Premunire (præmonere) *facias*—by this the convicted incur the penalty of imprisonment for life, and forfeiture of all goods and rents of lands.

Qui tam Actions.

If any one has begun a Qui tam action, no other person can pursue it, and the verdict passed on the defendant in the first suit is a bar to all others, and conclusive even against the king himself. This has frequently occasioned offenders to procure their own friends to begin a suit in order to forestal and prevent other actions.*

Damages.

One farthing damages carry costs.

The First Wrong.

It is a fundamental principle in law and reason, that he who does the first wrong shall be answerable for all consequential damages.

Judicial Decisions.

On account of the enormous multitude of our judicial decisions, people mistake the variety for confusion, and complicated cases for contradictory ones.

Recovery.

Recovery, feigned or common, is a sort of fictio juris, to destroy estates tail, remainder, and reversions, and to bar entails.

* For instance, when a man marries two sisters, he gets a friend to institute a prosecution against him, which bars all others.

Suppose David Edwards be tenant of a freehold, and desires to suffer a common recovery to bar all entails, remainders, and reversions, and to convey the same in fee simple to Francis Golding.

To effect this, Golding sues out a writ alleging that the defendant, Edwards, has *no title* to the land in question;* having come into possession of it after one Hugh Hunt had turned the petitioner out of it. The tenant (Edwards) calls on Jacob Moreland, (the vouchee,) who is supposed originally to have warranted the title, to appear and defend the title, which he does. Golding then desires to speak with the vouchee in private, which is permitted; the consequence of which is, that Moreland, the vouchee, disappears, and makes default. Upon this event judgment is given for Golding, now called the recoveror, to recover the lands from Edwards, who, on his side, has judgment for an equivalent in land from Moreland. But this last, who is usually the cryer of the court, and common vouchee, having no lands, Edward has of course only a nominal recompense for the lands recovered against him by Golding, to whom seisin is delivered by the sheriff. This collusive recovery operates as a conveyance in fee simple from Edwards, the tenant in tail, to Golding, the purchaser.

These ingenious fictions were invented by the ecclesiastics to evade the statute of mortmain, and in order to put an end to all fettered inheritances.

Sergeants at Law.

As sergeants (sergente, Italian) at law are supposed to be most learned and experienced, there is one court appropriated for them to plead in, which is the

* This allegation appears to be a perfect master-piece of impudence, when it is the very confidence in the justice of Edwards's title that makes Golding become the purchaser.

Common Pleas; but they are not prohibited from pleading in other courts; and all judges, who must first be sergeants, call them brothers. They are called by the king's mandate or writ, and some are peculiarly king's sergeants, who plead for him in all cases, especially of treason.

The Power of the Parliament.

The parliament can do every thing except make a man a woman, and vice versa.

In every government whatever be its form, a controlling power, perfectly despotic, must exist somewhere. In England it rests with the parliament.

Acts of Parliament.

The most usual method of citing acts of parliament is by naming the year of the king's reign in which the statute was made, together with the chapter or particular act according to its numerical order; Geo. II. c. 4. All the acts of one session of parliament make properly but *one* statute, and therefore when two sessions have been held in one year, it is usual to mention stat. 1. or 2.

The House of Peers.

Henry VII. could only summon 28 temporal peers to his first parliament: and only 36 were summoned to the first parliament of Henry VIII.

A.D. 1670, the temporal peers were 154, the prelates 26=180.

In 1735 the house of peers consisted of 194 noblemen and 26 bishops=220, which includes the Scottish peers. The dukes were then 30.

Since that date the dukedoms of Cleveland, Buckinghamshire, Montague, Dover, Kent, Newcastle,

Greenwich, &c. &c. have become extinct in the then existing line.

In A.D. 1820, the house of peers consisted of 371 persons.

The House of Commons.

			Members.
Henry VIII. found at his accession	147 places, returning		296
He added	32 places, returning		38
Edward VI.	22	ditto	24
Mary	12	ditto	22
Elizabeth	31	ditto	62
James I.	14	ditto	27
			173
Increased by the authority of Parliament, from that date to the Union			44
Total for England			513
A.D. 1706, added by the Union with Scotland			45
Total, Great Britain			558
By the Union with Ireland			100
Grand Total			658

The People.

The people are the natural prey of mountebanks and impostors.

The Optimates.

According to Cicero's description, the Optimates were the best citizens, who desired their actions to

be approved of by the better sort; and the Populares those who, out of a thirst for vain glory, did not so much consider what was right, as what would please the populace.

The Chiltern Hundreds.

A member of parliament cannot resign, but the king may grant him the office of steward to the Chiltern Hundreds, the acceptance of which vacates his seat. The Chiltern Hundreds are crown lands in Bedfordshire and Bucks, not far from Aylesbury, their topographical name arising from the chalky nature of the hills, of which they principally consist.

Shires.

The names of almost all the counties or shires in England are mentioned in history before the extinction of the Saxon heptarchy.

Scottish County Votes.

In 1811 the number of freehold county votes in all Scotland was 2417. Ayrshire had 151; Renfrewshire, 76; Inverness-shire, 49; and so on.

Innovation.

Lord Bacon remarks, Quis novatur tempus imitatur, quod novationes ita insinuant ut sensus fallant, (whoever innovates let him imitate time, which so gradually insinuates its innovations that they deceive the sense.)

Freeholds.

In England a lease for life, of 40*s*. per annum value, is a freehold, and qualifies the owner to vote

for a member of parliament. A great proportion of the yeomanry have freeholds.

In Scotland no leasehold gives a vote for a member of parliament.

Single Combat.

In the 13th year of Queen Elizabeth, "a combat was appointed to be fought for a certain manor, and the domain lands thereto, in Kent." In the end the matter was compromised, but not until the usual forms had been observed by the two parties, of which we have a curious and circumstantial detail in Holinshed's Chronicle.

Original Electors of Germany.

Mentz, Treves, Cologne,
Bavaria, Saxony, Bohemia, Brandenburg. } Seven.

No Austria, no Palatine, no Hanover.

No New Sovereign in May.

It is remarkable that among the thirty-two sovereigns who have sat on the English throne since William the Conqueror, although each of the eleven months has witnessed the accession of one or more, the month of May has not been so fortunate, none having ascended the throne within its limits.

Government.

The whole system of polity and government is a compromise betwixt what is perfect in theory and what is practicable in execution. Human nature cannot be changed; we must therefore frame our institutions according to what it is, not according to what it ought to be.

Judging from experience, no government is popular until it has ceased to exist: in fact, it would

seem the main business of man to repine at all government, yet there is manifestly no real equality either in nature or society.

Ultraism.

Whenever an irrational ultraism in politics has become so popular as to prove a dangerous epidemic, Providence produces a state of adversity, such as compels the re-agency of reason.

It is a blind policy that admits of no distinctions, and which would apply the same rules and maxims at all times, and under all circumstances.

Comparative Efficacy of Laws.

With respect to efficacy of human laws, their direct power to inspire men with the love of probity, diligence, and contentment, by positive command, is small; their power to restrain the opposite vices is far greater; their power to discourage or hinder *good habits* of character, by mistaken institutions, greatest of all.

In the case last mentioned, they operate at an advantage; because the institution, and the bad part of human nature go together; whereas, in the other cases, they are opposed, and the enactment has to force its way against the grain.*

Legislation.

To suppose that legislation is a specific remedy for moral and political grievances, is a very prevalent error of the age.

Property.

The laws of nature dictate to man the establish-

* Virtus rectorem ducemque desiderat; vitia sine magistro discuntur. Virtue requires the aid of a governor and director; vices are learned without a teacher.

ment of property, and of a power capable of protecting it. So strongly is this sentiment impressed on the human heart, that nothing seems to be thought so absolutely intolerable as the prevalence in society of the right of the strongest, to escape from which, there is scarcely any degree of tyranny and oppression from a single person and his satellites, to which rational beings will not submit, rather than be at the mercy of the first stronger man who may chuse to possess himself of the fruits of their labour. The inevitable consequence, therefore, of anarchy and confusion of property is *despotism*.

Misnomers.

Cheated in names, military licentiousness being called liberty.—" Nomina rerum perdidimus, et licentia militaris libertas vocatur." (Cicero.)

Institutions of the Chinese.

The political institutions of the Chinese are remarkable among those of Asiatic nations, or indeed any other, for the uncommon share of tranquillity they are found by long experience capable of maintaining, and for the security they afford to life and property.

Chinese Ranks.

The Chinese rank the cultivators of the mind in the first class; the cultivators of the land in the second; the operators on the earth's produce (artizans, mechanics, &c.) in the third; and, finally, the transferrer of commodities (traffickers, traders and merchants) in the fourth class.

The priests of China are not allowed to hold any, even the lowest place, in the magistracy; the literati are the privileged caste, and being possessed of power, are as exclusive and domineering as any hierarchy could be.

Caste.

So far as the distinction of caste checks progressive improvement, and permanently degrades a large portion of the people, it is injurious to society; but so far as they perpetuate the arts, and tend to prevent further deterioration, as they repress irregular passions, and promote tranquillity and subordination, their influence is beneficial.

In a country and climate pre-disposed to improvement, the shackles of caste must be a curse, but where retrogression of intellect is much more to be apprehended, they are decidedly useful. Hindostan has hitherto belonged to the last description of nations, and has consequently been upheld in the scale of civilization by the doctrine of caste; at present its destiny is entirely altered, and it may be expected the Brahminical system will be gradually relaxed, and at last, whether for the better or the worse, disappear. A great error, however, may be committed by unduly accelerating this event, or attempting prematurely to overthrow an ancient system, before the people are prepared for the change.*

Ferintosh Whiskey.

The word Ferintosh signifies Thane's land, it having been part of the Thanedom of Cawdor, (Macbeth's) or Calder.

The barony of Ferintosh belonged to the Forbes's of Culloden, and contained about 1800 arable acres. All barley produced on this estate was privileged to be converted into whiskey, duty free; the natural consequence of which was, that more whiskey was distilled in Ferintosh than in all the rest of Scotland.

* Without a hereditary nobility, wealthy and independent land proprietors, and an elevated and intelligent hierarchy, knowledge cannot accumulate; nothing is permanently added to the prior stock, which is the natural check to misgovernment.

In 1784, government made a sort of compulsory purchase of this privilege from the Culloden family, after they had enjoyed it a complete century. The sum paid was £21,500.

Insurrections.

In all popular and universal insurrections, "communis error facit jus; et consuetudo peccandi minuit et crimen et pœnam."

Might.

Might gives right, and all things are the property of the valiant.—"In armis jus ferre, et omnium fortium virorum esse." (Livy.)

Prosperous villainy is called virtue.

Robbery on a large Scale.

Rome sustained herself, and lived upon, "magna et sanguineolenta latrocinia."

National Allegiance.

In the civil law "Partus sequitur ventrem;" but the national character is determined by the father according to the English law. "Lege Angliæ nunquam matris sed semper patris conditionem imitari partum judicat."

Usurpers.

Never kingdom badly obtained was well administered. "Nec quisquam imperium malis artibus quæsitum bene administravit." (Tacitus.)

Slaves.

Geraldus Cambrensis writes, that so many villeins were in his time exported to Ireland, that the slave-market there was quite glutted.

Another author declares, that from the reign of King William to King John, there was scarcely a

cottage in Scotland that did not possess an English slave.

Assiento.

This is a Spanish word, signifying a "farm," and was formerly used to denote a bargain between the king of Spain and other powers for permission to import negroes into the Spanish dominions in South America, and more especially to Buenos Ayres. The first Assiento was made with the French Guinea Company, and by the treaty of Utrecht,* transferred to the English, who were to furnish 4800 negroes annually.

Judicial Establishments.

In England. 12 Judges, 10 Masters in Chancery, and the Lord and Vice-Chancellor, compose the judicial establishment. In France, exclusive of the justices of the peace, there are altogether 5600 stipendiary judges and magistrates.

In England and Wales, in 1823, there were 4430 acting county magistrates; but as many of these act under different commissions, the real number is no doubt less.

The Tread-Mills, and Milbank Penitentiary.

At Lewes, each prisoner walks at the rate of 6600

* Peace with France might have been concluded on infinitely better terms, two years before the treaty of Utrecht; but the negociations were broken off principally on account of this Assiento, which Great Britain most pertinaciously insisted on, and Louis XIV. at last most reluctantly conceded, although he gained political objects of great magnitude. Several bloody battles, and still more bloody sieges, took place, and much treasure was expended; but the English nation, however disunited in other respects, was unanimous in its determination to engross this now reprobated privilege, which, although nominally limited to 4800 negroes, furnished a pretext for smuggling in three times that number. On such matters, national feelings seem periodically subject to hot and cold fits.

feet *in ascent* per day; at Ipswich, 7450; at St. Alban's, 8000; at Bury, 8950; at Cambridge, 10,175; at Durham, 12,000; at Brixton, Guildford, and Reading, the summer rate exceeds 13,000; while at Warwick, the summer rate will be 17,000 feet in ten hours.

In the spring of 1823, Milbank Penitentiary contained 869 prisoners; the officers and their families amounted to 106. Total within the walls, 975 persons.

Abuse of the Laws.

Nothing is more unreasonable than from the possible abuse of a law, to found an argument against the law itself. The king can create as many peers as he chooses, but is it likely that he would make every man in the kingdom a peer?

Popularity.

In a free country, when a public functionary has the reputation of being what is vulgarly called popular, there is a strong suspicion that he is evading or betraying his duties. Popularity is very different from public estimation.

Political Nostrums.

He (or a nation) is miserably unwell, who is in greater danger from his physician than from his disease. "Infeliciter ægrotat cui plus periculi a medico quam a morbo." (Seneca.)

We can neither bear the disease nor the remedy "Nec morbum ferre possumus nec remedium." (Livy.)

To do or not to do.

In politics as in common life, to know what can be done, and how to do it, is a most valuable species of information; the next is, to know what cannot be

done, and why we cannot do it. The first enables us to attain a positive good; the second saves us from the mortification of fruitless attempts.

History.

History transmits to us the memory of great political revolutions, wars, conquests, and other scourges of humanity; but it furnishes no information of the more or less deplorable lot of the poorest and most numerous class of society.

Circumspection.

No greater mistake in legislation can be committed, than to treat the labouring or any other class of society as incapable of the superintendence of their own concerns; for they, as well as their superiors, when guilty of thoughtlessness or vice, ought to be left to feel the consequences of their own misconduct. We ought never, therefore, by redundance of care, to destroy that circumspection which every person should be obliged to exercise in the management of his own affairs.

Punishment.

The law commonly enhances the punishment in proportion to the greatness of the circumstance, (the temptation to commit the crime,) which apparently ought to alleviate the penalty.

National Ambition.

" Les Romains étaient ambitieux par orgueil, et les Carthaginois par avarice. Les uns voulaient commander, les autres voulaient acquérir; et ces derniers, calculant sans cesse la recette et la dépense, firent toujours la guerre sans l'aimer. Mais lorsqu'une nation est venu au point qu'on ne peut plus s'em-

pêcher de la voir, chaqu'un cherche à priver cette nation d'un avantage qu'elle n'a pas pris, pour ainsi dire, que par surprise." (Montesquieu.)

Decline and Fall.

No incidental events can make a nation little, while the principles remain in vigour that made it great.

Religious Liberty.

Religious liberty is like civil liberty, not immunity from restraint, but the being restrained by no law, but what is in a superior degree conducive to the public welfare.

BOTANY.

The science of plants; that part of natural history that relates to vegetables. (Johnson.)

It consists of three parts:

1. The physiology of plants, or a knowledge of the structure and functions of their different parts.

2. The systematic arrangement and denomination of their different kinds.

3. Their economical and medical properties.

Number of Plants.

Baron Humboldt states, that we have nearly 56,000 species of cryptogamous and phanerogamous plants. Of the last, the full number known in catalogues and herbaria is 38,000.

The Flower.

In the flower are to be observed:

1. The calyx, or green membranceous part, forming the support for the coloured floral leaves,

2. The corolla, which is either monopetalous or polypetalous.

3. The stamens and the pistils. The essential part of the stamen are the summits or anthers, covered with a fine dust named the pollen, which be-

ing deposited on the style, renders the seed productive.

The pistil is cylindrical, and surmounted by the style, the top of which is generally round and protuberant. It is connected with a vessel containing the rudiments of the seed.

No flowers have been discovered that have eleven stamina.

Seeds.

In every seed there is to be distinguished:

1. The organ of nourishment.
2. The nascent plant or plume.
3. The nascent root or radicle.

In the common garden bean, the organ of nourishment is divided into two lobes, called cotyledons. The plume is a small white point between the upper part of the lobes; the radicle is the small curved cone at the base.

Seeds are incapable of germinating, except when oxygen is present.

Dormant Seeds.

Crops of white clover spring up in appearance spontaneously, on the application of lime to dry heaths and barren soils; and raspberry-bushes start up where fir-woods have been burned down, though not a vestige of either could previously be discovered on the spot.

Elements.

Three elements, oxygen, hydrogen, and carbon, constitute the greatest part of the organized matter of vegetables.

The most common and important products of vegetables, such as starch, mucilage, sugar, and woody fibre, are composed of water, or its elements, in their due proportion, and charcoal.

Vessels.

In all plants there exists a system of tubes, or vessels, which at one extremity terminate in roots, and at the other in leaves.

Organs.

Every plant displays four systems of organs, or analogous parts, viz.

1. The root.
2. The trunk, branches, or stem.
3. The leaves.
4. The flower or seed.

The branch or root of a tree, when cut transversely, exhibits three distinct substances: the bark, the wood, and the pith.*

Germination.

For a healthy germination are required:

1. A due temperature, above the freezing point, and below 100° Fahrenheit.
2. Moisture in due proportion.
3. A proper access of air, the oxygen of which is slowly converted into carbonic acid.

The Sap.

The sap descending through the bark, after being modified by the leaves, is the principal cause of the growth of the tree. The alburnum is the great vascular system through which the sap rises.

The Wood.

The wood of trees is composed of an external or living part, called alburnum, or sap-wood, and an internal or dead part, named the heart-wood.

* Plants breathe like ourselves, but differently by day and night.

In the trunk of the tree there is a series of concentric layers, the number of which denotes the age of the tree. They are the accumulated remains of by-gone generations, in which vegetation and life are entirely extinct.

The Liber (or Inner Bark).

When vegetation revives in the woody plant on the return of spring, it is because a new liber has replaced in the cortex, or rind, the liber of the preceding year, which has hardened and become wood. All the great and ancient trees vegetate solely by their herbaceous layers of liber, annually produced at the inner surface of the bark.

Parenchyma.

Immediately under the epidermis, is a spungy, porous, cellular substance, named the Parenchyma.

The Age of Trees.

In consequence of the slow decay of the heart-wood of the oak and chestnut, those trees, under favourable circumstances, attain an age which cannot be much short of 1000 years. The beech, the ash, and the sycamore, most probably never live half so long. The duration of the apple-tree is not probably much more than 200 years; but the pear-tree, according to Mr. Knight, lives through double that period. Most of our best apples are supposed to have been introduced into Britain by a fruiterer of Henry VIII., so that they are now in a state of extreme old age.*

* Bishop Watson says: "Planters of trees ought to encourage themselves by considering all future time as present; indeed, such consideration would be a useful principle to all men in their conduct of life, as it respects both this world and the next."

Charcoal.

In general, the quantity of charcoal afforded by woods offers a tolerably accurate indication of their durability. Those most abundant in charcoal and earthy matter are the most permanent, while those that contain the largest proportion of the gazeous elements are the most perishable. Among our own trees, the chestnut and the oak are the most permanent, and the chestnut affords rather more carbonaceous matter than the oak.

The Leaves.

Absorption and evaporation principally take place from the lower surface of the leaf.

The leaves of several plants are covered with bristles, which in the nettle are perforated, and contain a venomous fluid.

Chemical Botany.

M Gay Lussac, and other French chemists, have deduced three propositions, which they have called laws, from their experiments on vegetable substances:

1. That a vegetable substance is always acid, whenever the oxygen it contains is, to the hydrogen, in a greater proportion than in water.

2. That a vegetable substance is always oily, or resinous, or spirituous, whenever it contains oxygen in a smaller proportion to hydrogen than in water.

3. That a vegetable substance is neither acid nor resinous, but is either saccharine or mucilaginous, or analogous to woody fibre or starch, whenever the oxygen and hydrogen it contains are in the same proportion as in water.

Sunshine.

In the sunshine, vegetables decompose the carbonic acid gas of the atmosphere, the carbon of

which is absorbed and becomes part of their organized matter, and the oxygen, which is the other constituent, is thrown off. In the dark, no oxygen is produced by plants, and no carbonic acid absorbed.

In many matters appertaining to vegetation, light is of more importance than heat. The pine-apple can now be cultivated and ripened without fire.

Dead and Living Matter.

Plants alone have the power of deriving nourishment, though not exclusively, from inorganic matter, such as mere earths, salts, or airs, substances certainly incapable of serving as food for any animals; the latter feeding solely on what is or has been organized matter, either of an animal or vegetable nature. It would seem to be the peculiar office of vegetable life, to transform dead inert matter into living organized bodies.

The germ or embryo of a plant or animal is able to attract to itself particles of inanimate matter, and bestow on them an arrangement widely different from that which the laws of chemistry and mechanics would have assigned them.

Poisonous Plants.

Five stamina, one pistil, one petal, and the fruit of the berry kind, indicate poisonous plants.

The calyx double, glume valved, three stamina, two pistils, and naked seed, indicate plants of a farinaceous quality, and fit for food.

Effect of Poisons on Plants.

Metallic poisons act on vegetables nearly in the same manner as they act on animals; the poisons that affect vegetables are chiefly those which are known to destroy animals by their action on the nervous system; such also cause the death of plants.

Carbonic acid, azote, and some other gases, have proportionate effects.

Minimum of Temperature.

In Europe, it is observed that the minimum of the mean temperature which a proper cultivation requires, is:

For the Sugar-cane, from 66° to 68° Fahrenheit.

Coffee	64°
Orange	62°
Olive	56 to 57°
Vine yielding wine fit to be drank	50 to 51°·8

The white birch-tree is found nearer the pole, and on more elevated situations, than pines, firs, or any other tree.

The heat of plants, in many instances, is above that of the surrounding medium.

The Sleep of Plants.

The common chickweed, with white blossoms, affords a notable instance of what is called the sleep of plants; for every night the leaves approach in pairs, so as to include within their upper surface the tender rudiments of the new shoots, while the uppermost pair but one at the end of the stalk are furnished with longer leaf-stalks than the others, so that they close on the terminating pair, and protect the end of the branch.

Efflorescence.

The earliest periods of the efflorescence of the following flowers, in lat. 53° 30′, (nearly that of Manchester,) are the following, viz.

January.

14th. Ulex Europæas—the common furze.

16th. Bellis perennis—the common daisy.

February.

2d. Helleborus fœtidus—stinking hellebore.
12th. Senecio vulgaris—groundsel.
14th. Galanthus nivalis—the snow-drops.
Crocus vernis—the spring crocus.
Vinca minor—the lesser perriwinkle.
26th. Daphne mezereon—mezereon.

September.

8th. Colchicum autumnale—the meadow saffron.
Arbutus unedo—the strawberry-tree, and water starwood.

October.

13. Hedera helix—the common ivy.

Rapid Maturity.

In the neighbourhood of Rio Janeiro, the common garden pea has been sown, flowered, gathered, and the haulms removed, within the short space of 21 days.

Dycotyledons.

As there are among the dycotyledons, that is to say, among the more perfect plants, no species which are at the same time indigenous in the hot climates of the old and new worlds, so both halves of the globe, in the same zone, possess mammiferous animals, birds, reptiles, and insects, peculiar to

Palms.

Palms are rather perennial herbaceous plants than trees. They are formed of successive circular crowns of leaves, which spring directly from the root. When one circle of these has performed its office, another is formed within it, which being confined below, generally rises a little above the former. Successive circles thus grow one above the other, and the verti-

cal increase of the plant is almost without end. Each circle of leaves is independent of its predecessor, and has its own cluster of vessels, so that there is no aggregation of woody circles.

Foxglove.

The English word foxglove, comes from digitalis Fuchsius, from the resemblance of the flowers to the finger of a glove; and Fuchsius, the name of a German, who first applied the name to the plant.

Lichens.

In the progress of nature, lichens first cover the exposed surface of a rock, and by the retention of moisture, accelerate its decomposition. The mosses next establish themselves in hollows and crevices, and by degrees prepare a bed for staminiferous vegetables, these last endeavour to banish their predecessors to the still more barren districts. The reindeer moss, or lichen, unlike other plants, is in full growth during the winter season.

The Rose.

The genus rosa found in Europe, has reached us from the East Indies, China, and Japan. The middle parts [illegible] Russian empire, and the districts around Caucasus and Persia are full of roses, of which these of [illegible] are mere varieties. Roses are rare in Africa [illegible] they are met with only in the northern [illegible] while Europe, from the Uralian mountains to [illegible] of Portugal, abounds with them. The roses of [illegible] ica have reached that continent through the polar lands. There are no roses in Australasia, nor have any species been met with in South America; indeed, they scarcely occur any where south of the equator.

The Hedysarum Gyrans.

This plant has a spontaneous motion in its leaves, independent of any external stimulus, even of light, and only requiring a very warm still atmosphere to be performed in perfection. Each leaf is ternate, and the lateral leaflets are frequently seen moving up and down, either equably or by jerks, without any uniformity or co-operation among themselves.

The Virginian Creeper.

This creeper has a small tendril, ending in a claw, each toe of which has a knob, thickly set with extremely small bristles, which grow into the invisible pores of the wall, and swelling, stick as long as the plant lives. The vanilla plant climbs round trees by means of tendrils, which, when it has properly fixed itself, drop off and give place to leaves.

Stinging Nettles.

Caterpillars are not deterred by the envenomed armour of the stinging nettles from climbing and eating them; yet they would appear to be peculiarly offensive to such delicate skinned animals.

Bamboos.

Bamboos are gigantic grasses, which in some parts of India are believed to bear fruit as they attain the age of 15, and to die immediately afterwards. When very young, you may almost see them grow, and they sometimes attain the height of sixty feet. They have been known to spring 30 inches in six days.

Rattans.

The epidermis (or scarf-skin) of the rattan contains a sufficient quantity of silex (or flint) to give light when struck with a steel; and silex also generally exists in the epidermis of hollow plants.

The Teak Tree.

The teak-tree, like the oak, takes from 50 to 100 years to come to maturity. It will often grow to the height of 80 feet, and has been known to attain a diameter of 5, 6, and even 8 feet. Its geographical distribution is comparatively limited; the Deccan, and south of India, India beyond the Ganges, and the island of Java, being its favourite habitations.

Teak is stronger than oak, and rather more buoyant. Its durability is more decided, and, unlike the oak, it may be put in use almost green from the forest, without danger of wet or dry rot. The oak contains an acid which corrodes and destroys iron; the teak, on the contrary, possesses an essential oil, which tends to the preservation of iron. In consequence of this last quality, however, it is unfit for the fabrication of casks or vessels to contain liquids, except arrack, to which it imparts a peculiar flavour.

The Date Tree.

The Emperor Baber, in his memoirs written by himself about A.D. 1520, says, "They say the date alone, of all the vegetable kingdom, resembles the animal kingdom in two respects: the one, if you cut off the top of a date-tree it withers and dies; the other is, that as no animal bears without concourse with the male, in like manner, if you do not bring a branch of a male date-tree, and shake it over the female, it bears no fruit. I cannot vouch for the truth of these remarks."

The Oak and Larch.

Not more than 40 oak-trees can stand on an acre of ground, so as to grow to a full size fit for a ship of the line.

The timber of the larch thrives well, and grows well in bad soils and exposed situations; yet its timber has been found to be very durable, and, from several experiments, not inferior in strength, toughness, and elasticity, to the oak.

The oak is found growing as freely in Eastern Tartary, China, Cochin China, Hindostan, Persia, and Japan, as in Europe.

The Peach Tree.

A gentleman at Madras says, he found the best way of raising peach-trees was, to take the kernel out of the stone and plant it by itself. The trees came up in 8 or 10 days.

The Clove.

The clove of commerce is, in fact, the flower before its expansion. The fruit is a very different thing, and quite unknown as an article of commerce.

The Orange Tree.

At St. Michael's and the Azores Islands, there are oranges throughout the whole year, but the principal crop is in January. The usual crop of a good orange-tree, in common years, is from 6000 to 8000; instances, however, have occurred, of from 26,000 to 29,000 having been gathered from one tree.

The Cotton Plant.

There are several species of the gossypium, or cotton-plant; one is annual, and another a biennial

plant. The produce of the cotton-tree (the bombax) is not used in any fabric. The cotton-plant of the United States is an annual, but in Columbia it is a perennial, and will continue productive, bearing for five or six years.

Odours.

The particular odours of plants seem in all cases to depend upon the peculiar volatile oils they contain. By collecting the aromatic oils, the fragrance of the flower, so fugitive in the common course of nature, is preserved, and as it were embodied and made permanent.

Aromatic Oils.

Volatile or odorous substances seem particularly destructive to the minute insects and animalcules, that feed on the substance of the vegetables.

Thousands of aphides may usually be seen in the stalk leaves of the rose, but none are ever observed in the flower. The woods that contain aromatic oils are remarkable for their indestructibility, and for their exemption from the attacks of insects, which is particularly the case with the cedar, rose-wood, and cypress.

Rouge.

The yellow colouring matter of flowers is the most permanent. The carthamus contains a red and yellow colouring matter; the latter is easily dissolved by water, and from the red, rouge is prepared by a process which is kept secret.

Gum.

The characteristic properties of gum are its easy solubility in water, and its insolubility in alcohol.

Mucilage is a variety of gum, but has less attraction for water.

Resin.

Resin is insoluble in water, but very soluble in alcohol.

Tar and pitch consist principally of resin in a partially decomposed state. Tar is made by the combustion of the fir-tree, and pitch by the evaporation of the more volatile parts of the tar.

Gluten.

Gluten may be obtained from wheat-flour by the following process:—The flour is to be made into a paste, which, after being carefully washed by kneading under a small stream of water, until this fluid has carried away all the starch, what remains is the gluten, which is a tenacious, ductile, elastic substance, without taste. It is very slightly soluble in cold water, and is subject to the caseous fermentation. It appears to be an extremely nutritive substance, and wheat seems indebted for its superiority to the large quantity of gluten it contains.

Indigo.

Indigo is not soluble in water, and but slightly in alcohol. Its true solvent is sulphuric acid. Mr. Dalton considers the value of indigo to be in proportion to the quantity of real oxymuriate of lime necessary to destroy its colour, and that a tolerable estimate of its value may be made from the quantity and intensity of the amber-coloured liquid produced by the indigo during the process.

Albumen.

Albumen, in its pure form, is a thick, glairy, tasteless fluid, precisely the same as the white of an egg.

It abounds in the juice of the papau-tree, and is likewise found in mushrooms, and in different species of funguses. Albumen is common both to the animal and vegetable kingdoms, and most abundant in the first. It may be distinguished by its property of coagulation, by the action of heat or acids, after which it is no longer soluble in water.

Opium.

Opium is very soluble in all acid menstrua. The garden lettuce contains a milky juice, which, when inspissated, has the character of opium, and certainly contains the same narcotic principle.

Tea.

In Great Britain, teas are divided into three kinds of green teas, and five of bohea.

The Green Teas are:

1. Imperial or bloom tea. It has a large leaf, a faint smell, and a light green colour.
2. Hyson. Small curled leaves of a green shade, inclining to blue.
3. Singlo. Thus named from the place where it is cultivated.

Boheas, or Black Teas:

1. Souchong, which, on infusion, imparts a yellowish green colour.
2. Camho. A fine tea, emitting a fragrant violet smell, and of a pale shade.
3. Pekoe. This is known by the small flowers which are mixed with it.
4. Congo. Has a larger leaf than the preceding variety, and yields a deep tint to water.
5. Common bohea tea, the leaves of which are of a uniform green colour.

Gunpowder teas differ from the above kinds only in the minuteness of their leaves, and being dried with additional care.

In its natural state, tea is a narcotic plant, on which account the Chinese refrain, until it has been divested of this property by twelve months keeping.

Dr. Clarke Abel says, the strongest tea he tasted during his travels in China was named "Yu-tien," yet it scarcely coloured the water. It is reserved for occasions of ceremony, and consists of the hardly expanded buds of the plant.

Sir G. Staunton and Mr. Ellis assert, that green and bohea tea are plants of one and the same botanical species, the variation in the quality depending on the soil, the age at which the leaves are plucked, and the subsequent management and mixture of them.

Starch.

Starch forms a principal ingredient in the composition of a number of esculent vegetable substances besides wheat, potatoes, &c. &c. Sowans, cassava, salop, sago, all owe their nutritive powers chiefly to the starch they contain.

The ultimate elements of starch and sugar differ very little. Starch is converted into sugar during the germination of the seeds, and in the process of malting. Malt is barley which has been made to germinate to a certain extent, after which the process is stopped by heat.

Barley malted contains		Barley not malted	
Gum	14 parts	Gum	5
Sugar	16	Sugar	4
Gluten	1	Gluten	3
Starch	69	Starch	88
	100 parts.		100 parts

Starch Sugar.

If starch be boiled for 48 hours in water, holding $\frac{1}{100}$th part of its weight of sulphuric acid in solution, it is dissolved and converted into sugar. The sugar thus acquired is heavier than the starch from which it was formed, the sulphuric acid remains unaltered, and no gaseous substance is either absorbed or emitted.

Starch sugar does not crystallize into prisms like common sugar, the grains assuming the form of spheres like honey. According to Kirchhoff, its sweetening power is to that of common as 1 to $2\frac{1}{2}$.*

Sweet Potatoes.

Frost converts the starch and mucilage of the potatoe into sugar. When potatoes that have been frozen are thawed, they become sweet, probably from oxygen having been absorbed. To remedy this, they ought to be thawed out of contact with the air, as under water that has been recently boiled.

Saccharine Matter.

There are two perfectly distinct kinds of saccharine matter, white barley-sugar and treacle; the one crystallizable and transparent, the other highly coloured, and not crystallizable.

Ardent Spirits.

No other substance than sugar can be converted by fermentation into ardent spirits, which, whatever be their name, consist almost entirely of these ingredients, viz. water, pure spirit or alcohol, and a little oil or resin, which flavours them.

* This appears doubtful.

Tannin.

A bitter astringent substance procured from plants, bark, &c. that contain charcoal. It is soluble in water and alcohol, but not in ether. The characteristic of tannin is its action on solutions of isinglass or jelly.

When skin is exposed to solutions containing tannin, it slowly combines with that principle; its fibrous texture and cohesion are preserved, it is rendered insoluble in water, and is no longer liable to putrefaction.

Indian Rubber.

Caoutchouc, gum elastic, or Indian rubber, is soluble in ether, but not in alcohol. Birdlime (a substance procured from the holly) is very analogous to gum elastic in its properties.

Wines, where produced.

Wines of Champagne.—Ay, Epernay, Hautvillier, Sillery, &c.—The varieties of pink Champagne are either tinged by the husk of the grape, or by a colouring matter composed of elder-berry juice and cream of tartar.

Wines of Burgundy.—Romané, Conti, Clos Vougeot, and Chambertin. White Burgundy, from Mont Rachet, la Perriere, and Chablis.

Wines of Dauphiné, the Lionnais, and Avignon.—Hermitage from Tain on the banks of the Rhone, about seven miles from Lyons.

Wines of Languedoc.—Frontignan, Lunel, and Beziers.

Wines of Rousillon.—Rivesaltes (two leagues east of Perpignan) and Salces. These are sweet or muscadine wines.

Gascony and Guienne.—The vineyards of the Bordelais are those of Medoc, Graves, Palus, and Vignes

Blanches, which furnish the prime wines. Medoc comprehends the vineyards of Lafite and Latour, Leoville, Chateau Margaux, and Rausan.

Claret.—To each hogshead of genuine Bordeaux wine, there are four gallons of Benicarlo, half a gallon of stum wine, and a small quantity of Hermitage added, which mixture undergoes a slight fermentation, and is then exported under the name of Claret. Sometimes to that intended for England, a small quantity of raspberry brandy is added.

St. Bris, Carbonnieux, Sauterne, Barsac, and Preinac, are white wines of Guienne and Gascony.*

Spanish Wines.—Sherry, Alicant, and Malaga.—The grapes for the Sherry are placed in the vats with a layer of burned gypsum on the surface, and are trodden by peasants wearing wooden shoes. Sometimes bitter almonds are infused while the wine is in the vat, to give it a nutty flavour.

Tintilla, or Tinta di Rota, is a red wine of Andalusia.

Rhenish Wines.—The best are—Schoss Johannis, Berger, Steinberger, and Hocheim.

Tokay, from Hungary.

Italian Wines.—Ligustico, a Genoese wine like Champagne; Aleatico, a Tuscan wine. In the Papal states, the muscadel wines of Albano and Montefrascone. Lachrymi Christi is a Neapolitan wine; Marsala, a Sicilian wine.

Malmsey and Sercial, from Madeira; Constantia, from the Cape of Good Hope.

* Nearly one-third of the wine made in France does not cost the maker more than three centimes per quart; in English money, about three-tenths of a penny.

AGRICULTURE, &c.

TILLAGE; the art of Husbandry as applied to the cultivation of the earth.

Origin of Soil.

Soils appear to have been originally formed in consequence of the decomposition of rocks, and it frequently happens that soils are found in an unaltered state on the rocks from which they are derived. It is easy to form an idea of the manner in which rocks have been converted into soils by referring to the instance of soft granite or porcelain granite, a substance consisting of three ingredients, quartz, mica, and feldspar. The quartz is almost pure silicious earth, in a crystalline form. The feldspar and mica, are compound substances; both contain silica, alumina, and iron. In the feldspar there is usually lime and potash; in the mica, lime and magnesia.

When a granitic rock of this nature has been exposed to the influence of air and water, the lime and potash contained in its constituent parts are acted on by carbonic acid or water, and the oxide of iron which is almost always in its least oxidized state, tends to combine with more oxygen;—the consequence is, that the feldspar decomposes, and likewise the mica, but the first with most rapidity. The feldspar, which is as it were the cement of the stone, forms a fine clay. The mica, partially decomposed, mixes with it as sand, and the undecomposed quartz appears as gravel or sand, of different degrees of fineness.

After this it is necessary to suppose some of the

soluble parts dissolved in water, and that water adhering to the mass, and the whole mixed with larger or smaller quantities of the remains of animals and vegetables in different stages of decay.

The Ingredients of Soil.

Soils are extremely diversified in appearance and quality, yet they all consist of different proportions of the same elements. The substances that constitute soils are certain compounds of the earths, silica, lime, alumina, magnesia, and the oxides of iron and manganese; animal and vegetable matter in a state of decomposition, and saline, acid, or alkaline combinations.

Barren Soils.

Pure silica or alumina, pure carbonate of lime, or carbonate of magnesia, are incapable of supporting a healthy vegetation, and no soil is fertile that contains so much as 19 parts out of 20 of any single constituent. The soil of Bagshot heath, which is entirely devoid of vegetable covering, contains less than $\frac{1}{20}$th of finely divided matter.

Bulbous Roots.

Plants that have bulbous roots require a looser and lighter soil than such as have fibrous roots; and the plants possessing only short fibrous radicles demand a firmer soil than such as have tap roots or extensive lateral roots. A crop of turnips may be raised in a soil containing 11 parts out of 12 of sand, and some bulbous roots will thrive in a soil containing 14 parts of 15 of sand; but a much larger proportion of sand will cause absolute sterility.

In all cases the ashes of plants contain some of the earth of the soil in which they were grown; but it never exceeds $\frac{1}{50}$ of the weight of the plant consumed.

Fertile Soils.

The best natural soils are those in which the materials have been derived from different strata, that have been minutely divided by air and water, and are intimately blended together.

The absorbent power of soils from atmospheric moisture is a proof of their fertility.

Improvement of Soils.

If there be an excess of calcareous matter in the soil, it may be improved by the addition of sand and clay. Soils too abundant in sand are benefited by the use of clay, marle, or vegetable matter. Stiff clays and marles have their earthy constituents in an impalpable state of division, and are improved by burning.

In general the natural operation of water is to bring earthy substances into an extreme state of division.

Winter Irrigation.

Water is of a greater specific gravity at 42° than at 32°, the freezing point; hence, in a meadow irrigated in the winter, the water in contact with the grass is rarely below 40°, a degree of temperature not at all prejudicial to the living organs of plants.

Exhalation.

From 2000 to 3000 gallons of water are exhaled in a day from an acre of land.

Limestone.

When limestone is strongly heated the carbonic acid gas is expelled, and then nothing remains but the pure alkaline earth.

As a cement, lime, applied in its caustic state, ac-

quires its hardness and durability by re-absorbing carbonic acid, when it again becomes limestone.

Magnesian limestones effervesce but little when plunged into acids.

Marle.

Marle is a natural mixture of limestone and clay in variable quantities.

Manures.

The decay and death of animal substances tend to resolve organized forms into their chemical constituents, and the disagreeable effluvia disengaged seem to point out the propriety of burying them in the soil, where they are fitted to become the food of animals. The fermentation and putrefaction of organized substances in the open atmosphere are noxious processes; beneath the surface of the ground they are salutary operations. In this case the food of plants is prepared where it can be of use, and that which would offend the senses and injure the health if exposed, in the earth is gradually converted into forms of beauty and utility. The fœtid gas is rendered a constituent portion of the aroma of the flower, and what might be poisonous becomes the nourishment of man and animals.

Putrefaction.

The circumstances necessary for the putrefaction of animal substances are similar to those required for the fermentation of vegetable substances; viz.—a temperature above the freezing point, and the presence of water and oxygen, at least in the first stage of the process. No putrefaction or fermentation can go on without the generation of elastic fluid, and water is as necessary as air to the process of fermentation.

The disagreeable smell of night soil may be destroyed by mixing it with quick lime.

If a thermometer plunged in dung does not rise above 100° Fahrenheit, there is little danger of much aeriform fluid flying off.

Sea-weed.

A heap of sea-weed, as large as a house when long exposed to the atmosphere, decays and disappears, nothing remaining but a little black [illegible]ous matter.

Predominating Grains.

In respect to the predominating grains, the earth may be divided into five grand kingdoms or divisions, viz. those of rice, of maize, of wheat and rye, of barley, and of oats. The three first are the most extensive; the maize has the greatest range of temperature; but rice supports the greatest number of human beings.*

Wheat, a Grass.

Wheat, in its indigenous state as a natural production of the soil, appears to have been a small grass; and the case of improvement by cultivation is still more remarkable in the apple and plum.

The best soil for a crop of wheat is that in which the earthy materials, the moisture and the manure, are properly associated, and in which the decomposable animal or vegetable matter does not exceed one-fourth of the weight of the earthy constituents.

* The consumption of all kinds of grain in England during one year has been estimated at 36,000,000 of quarters; of wheat 12,000,000 quarters.

Average Produce.

The average produce of an acre is—

	In England.			In Ireland.		
	Qrs.	Bush.	Pecks.	Qrs.	Bush.	Pecks.
Wheat . . .	3	0	0	2	2	3
Oats . . .	4	6	0	3	4	3
Barley . . .	4	0	0	3	4	3

In Scotland, the quantity of produce from a statute acre of a good soil, and in a favourable season, is—

Wheat, from 32 to 45 bushels.
Barley, . 48 to 55
Oats, . . 60 to 75
Turnips . 30 to 40 tons.
Potatoes . 8 to 10

The Scotch boll is equal to half an English quarter.

A bushel of good wheat ought to weigh 57 lbs.; barley 50: bear, 44; and of oats, from 37 to 39 pounds.

[illegible]600 pounds of wheat will yield 5400 pounds of bread.

The Loaf.

The wheaten loaf is made of the finest flour; the standard wheaten, of the whole flour mixed together; and the household, of the coarse flour.

A sack of flour 280 pounds weight produces 87 loaves of four pounds each, or 348 pounds of bread. The allowance to bakers is 13*s.* 4*d.* per sack. When a sack of flour, therefore, is 73*s.*+13*s.* 4*d.*=86*s.* 4*d.* the price of a four pound loaf ought to be 12*d.* or one shilling, and in proportion as the sack of flour is higher or lower.

Constituents of Wheat and Potatoes.

One pound of good wheat contains:—

	oz.	drs.
Bran	3	0
Starch	10	0
Gluten	0	6
Sugar	0	2
Loss	2	0
	16 ounces.	

Potatoes contain—	Water . . .	72·6
	Starch . . .	15·0
	Fibrous matter	7·0
	Albumen . .	1·4
	Mucilage . .	4·0
		100 parts.

Potatoes differ essentially from wheat in containing no gluten.

Rice.

If rice be used soon after it is gathered, (for instance within one or two months,) it is very unwholesome food.

It has been remarked, that the heat produced by rice, when heaped in large piles, will not allow insects to live in the inside of the heap, consequently the great wastage takes place at the outside surface. Keeping rice, therefore, for any length of time, either in small piles or in bags, is ruinous.

Cassada.

The cassada flour (termed in the Brazils farinha de pao) is left untouched by every description of insect, although in that extensive country it is the principal food of man.

ZOOLOGY, &c.

A Treatise concerning living creatures, or the natural history of the animal kingdom, but more especially referring to quadrupeds. Ornithology, Ichthyology, Entomology, &c. are properly subdivisions of this general head.

The Six Classes of Animals.

Class 1. Mammalia—suckle their young.
2. Birds—covered with feathers.
3. Amphibia—lungs arbitrary.
4. Fishes—breathe by gills not arbitrarily.
5. Insects—two antennæ or feelers.
6. Vermes (Worms)—no head.*

Periods of Gestation.

The Elephant	2 years	Sheep	5 months.
Buffalo	1 year	Lion	5 months.
Camel	1 year	Dog	63 days.
Ass	11 months.	Cat	8 weeks.
Horse	11 months.	Swine	4 months.
Cow	9 months.	Guinea Pigs	3 weeks.

Incubation.

The proper heat for hatching eggs is 104° Fahrenheit, to which degree the warmth of the body of the hen will raise the thermometer when she sits on

* The systematic name of man, as an animal, is "*Homo sapiens*;" with what justice we leave to the reader's own conscience.

the eggs. The full period of incubation by the hen in this country is 21 days; in warm climates it is a day or two less. The swan sits 42 days; parrot, 40; goose, 30; duck, 30; pigeon, 18; canary, 14. The length of life is said to bear some relation to the length of the different periods of incubation.

Fecundity.

So quick is the produce of pigeons, that in the course of four years, 14,760 may come from a single pair; and in the same period of time, 1,274,840 from a pair of rabbits.*

The Animal and Vegetable Kingdoms.

Baron Humboldt states, that we have nearly 56,000 species of cryptogamous and phanerogamous plants; 44,000 insects; 2500 fishes; 700 reptiles; 4000 birds; and 500 species of mammiferæ. It is probable that in the ancient catastrophes of our planet Tellus, many more mammiferæ than birds have disappeared.

Animals of New Holland.

If we except man and the dog, (and these without doubt have arrived in a comparatively recent period, so miserable is the condition in which they occur,) New Holland bears no resemblance in its organic nature to the rest of the world.

The Cuckow and Swallow.

The cuckow appears in Sussex about the third week in April; in the neighbourhood of Edinburgh, about the second week in May. From the time of

* Nature is redundant in every thing. A single pear-tree produces more blossoms than the sap of fifty trees could bring to maturity.

its arrival to its departure is usually only three months.

The common swallow appears in Sussex about the third week in April; in Edinburgh, about the second week in May.

The cuckow does not build any nest, but lays her eggs in the nests of other birds, but not indiscriminately, selecting those nests only which belong to birds that have bills of the same kind with herself, and consequently feed on the same kind of food.

Canary Birds.

Dr. Fordyce found, that when Canary birds, at the time of laying their eggs, are deprived of all access to carbonate of lime, (common limestone,) or other calcareous matter, the eggs produced have soft shells.

Rapid Flight of Birds.

The rapidity with which the hawk and many other birds occasionally fly, is probably not less than at the rate of . . . . 150 miles in an hour.

The common crow, 25 ditto.

A swallow . . 92 ditto, and the swift three times greater.*

Migratory birds probably about 50 miles per hour.

The Bones and Muscles of Birds.

If any quantity of matter is to be fabricated into a rod of a certain length, the rod will be strong in proportion to its thickness; and if the figure remains the same, that thickness can only be increased by making it hollow. Therefore, hollow rods or tubes of the same length and quantity of matter, have more strength than solid ones of less diameter. Now the bones of animals are all more or less hollow; but

* This appears scarcely possible.

birds have the largest bones in proportion to their weight, and their bones are more hollow than those of animals that do not fly. Birds can also, by means of air vessels, blow out the hollow parts of their bodies, when they wish to make their descent slower, rise more swiftly, or float in the air.

The muscles that move the wings of a bird downwards, in many instances constitute not less than the sixth part of the weight of the whole body; whereas those of a man are not in proportion one hundredth part so large.

Eyes of Birds.

Birds can suddenly change the form of their eyes, by means of a set of hard scales, drawn by fibres, placed on their outer coat, round the part where the light enters; so that by acting on these, it can squeeze the natural magnifier of the eye into a round shape while following an insect in the air, and relax them in order to flatten them, to see distant objects, such as twigs and branches. This power of relaxing and contracting the eye is possessed in a more remarkable degree by birds of prey. A singular provision is also made to enable a bird to wipe its eye clean—a kind of thrid eye-lid.

The Ostrich.

The ostrich lays and hatches her eggs in the sand, her form being ill adapted for that process, while the sand furnishes a natural oven, and the sun supplies the stead of animal warmth.

The Goat.

The goat eats hemlock (which destroys sheep) with impunity, and readily devours the smaller kinds of serpents. The Tibet goats eat horse-chestnuts, of which they are particularly fond, weeds, and most trash that other animals, even the pig, reject.

The Horse.

A male horse has 40 teeth when he has completed his full number; the mare usually but 36. They are divided into the cutting teeth or nippers, the cuspidatæ or tushes, and the molares or grinders. The age of a horse may be easily known by his teeth, under eight years of age, after which the usual marks wear out.

Arsenic may be given to horses with impunity to the amount of two drachms troy. White vitriol does not act as an emetic on the horse, which, owing to the structure of its stomach, is incapable of vomiting. Colocynth, which is so purgative to man, has very little effect on the horse.

A kind of third eye-lid is found in the horse, and called the *haw*, moistened with a pulpy substance or mucilage to take hold of the dust on the eye-ball and wipe it clean; so that the eye is hardly ever seen with any thing on it, though greatly exposed from its size and posture.

Mares, in the language of jockeys, become aged at seven years, horses at eight years. They are both so called until twelve or fourteen years, after which there is a sinking in and about the loins that denotes old age.

Fishes.

With respect to fishes, it is probable that a great number of species live in succession on each other, in proportion as they exceed each other in strength, voracity, and activity; their enormous reproduction being evidently destined to supply any vacuity this devouring system might otherwise occasion.

The air-bag of some fishes soon loses its muscular power, in consequence of the air being expanded by the action of the sun, when the fish has remained too long at the surface, which it then cannot quit. Sometimes, from increased expansion, the air-bag bursts.

The eyes of fishes are larger, in proportion to their size, than in quadrupeds, as we find the eye of the cod-fish equal in size to that of the ox.

The tongue of fishes is very imperfectly developed.

The extent of surface presented by the gills of a fish is very great. Dr. Monro calculated, that the whole gills of a large skate presented a surface equal to 2250 square inches, equal to the whole external surface of the human body.

The respirations of fishes are from 20 to 30 per minute.

The tail is the great instrument of swimming, the fins only serving to balance the fish and keep it level.

The age of a carp has been known to reach 200 years, and of a pike to 260 years.

One cod-fish was found to contain 3,686,760 eggs.
A flounder 1,357,400
A herring 36,960
A sole 100,362

Gesner would persuade us that many fish sleep, but this does not seem to be the fact, for this race of animals can have no eye-brows, nor any membrane to close and cover their eyes with, as other creatures have to whom nature has allowed sleep.

The Whale.

The late Mr. Hunter observes, that the cetaceous order of animals has nothing peculiar to fish, except living in the same element; their internal organization (lungs, heart, intestines, &c.) entirely resembling those of quadrupeds. They breathe by lungs, not by gills; suckle their young; have no scales, and a horizontal tail, the reverse of fishes.

It is a pure error to suppose that the great northern whale feeds on herrings, being totally incapacitated, by the structure of its throat and mouth, from swallowing so large a fish. Its food consists of

minute shrimps, beroes, clios, and other marine worms and insects, probably imperceptible to its own organs of sight. These are taken into its mouth along with a vast volume of water, and strained through the fibres of the whalebone fixed in its palate. The large whale has no teeth, and its throat is very narrow. The whale that pursues the herrings on the coast of Scotland, is the bottle-nose, an animal of very different anatomy and habits from the great northern whale.

Ambergrease is found in the intestines of the spermaceti, but only in those that are in a sickly condition.

The Herring.

We have no satisfactory authority for believing that the herrings breed in the northern seas, where they have never yet been observed in the real icy seas; nor have they ever formed a fishery on the coasts of Greenland and Iceland. When they first appear on the coast of Scotland, it is not in shoals, but in small numbers, and they are then taken with a feather or fly and a rod.

There is nothing to indicate a migration from the north; on the contrary, there is every reason to believe they breed in our own seas; but both the time of their breeding and of their visits are irregular and capricious. Much good money has been sunk by erecting buildings and establishing fishing stations, which the herrings afterwards abandoned. It is probable, the food of herrings consists of various medusæ, the presence of which is known by the luminous appearance of the water.

Oysters.

After the month of May, it is felony to carry away the caltch (the spawn adhering to stones, old oyster-shells, &c.); and punishable to take any oysters, ex-

cept those of the size of a half-crown piece, or such as, when the two shells are shut, will admit of a shilling rattling between them.

The liquor of the oyster contains incredible multitudes of small embryo oysters, covered with little shells, perfectly transparent, swimming nimbly about. One hundred and twenty of these in a row would extend one inch. Besides these young oysters, the liquor contains a great variety of animalcules, five hundred times less in size, which emit a phosphoric light. The list of inhabitants, however, does not conclude here, for besides these last mentioned, there are three distinct species of worms, (called the oyster-worm,) half an inch long, found in oysters, which shine in the dark like glow-worms. The sea-star, cockles, and muscles, are the great enemies of the oyster. The first gets within the shell when they gape, and sucks them out.

While the tide is flowing, oysters lie with the hollow side downwards, but when it ebbs they turn on the other side.*

White Bait.

The young of the shad has been recently ascertained to be the little fish commonly known by the name of white bait.

Lampreys.

Having been unsuccessful in obtaining any male lampreys, (a fish like an eel,) although he procured in abundance what were considered to be females, Sir E. Home began to suspect that the individuals of the species were hermaphrodites, and his subsequent observations justified his conjecture, both with respect to the lamprey, and the common and conger eels.

* See Bishop Spratt on oysters.

Free Martins.

When a cow produces twins, their organs are frequently imperfect, and they are incapable of procreation, particularly when one happens to be a male, and the other a female. Such examples are termed Free Martins.

Eggs.

The manner in which the eggs of birds are impregnated has not been satisfactorily ascertained. With the exception of the cicatricula, (the hollow at the large end,) a bird, in the absence of the male, can produce an egg, but it is unfertile. In birds, one union suffices for the production of impregnated eggs during the period of laying; in the aphis, or plant-louse, it suffices until the ninth generation.

The Guimero Monster.

The mules of Sicily are strong and excellent, and in their attention to these, the Sicilians provide the finest asses that can be procured; but the guimero, or monster between a horse and a cow, or bull and a mare, though reared in Italy and Africa, is not esteemed in Sicily, it having proved more sluggish and obstinate than the mule.*—*(Capt. Smyth's Sicily.)*

The Dugong.

The habits of life of the manatee of the West Indies, place it between the dugong of the East Indian seas and the hippopŏtamus. It has no tusks, and feeds upon plants growing at the mouths of large rivers.

The dugong is the only animal yet known that grazes at the bottom of the sea without legs. It is

* Query:—*Is* the existence of this animal satisfactorily established? Dr. Johnson says, "*Jumart*, the mixture of a bull and a mare," and quotes Locke as his authority.

of the form and figure of the whale. The position and structure of the mouth enable it to browze upon the fuci and submarine algæ like a cow in a meadow, and the whole structure of the masticating and digestive organs, shows it to be truly herbivorous. It never comes on the land, or into fresh water, but frequents shallow inlets of the sea of two or three fathoms depth. The length of the dugong is eight or nine feet, and the flesh, when cooked, entirely resembles young and excellent beef.

The Walrus.

It is curious, that the hind feet of the enormous animal the walrus, are constructed (like the feet of the fly and other animals that walk against gravity,) upon a mechanism that resembles cupping-glasses, to enable it to adhere to the slippery rocks, which it is obliged to climb.

Hyænas.

It is quite impossible to mistake the jaw of any species of hyæna for that of the wolf or tiger kind; the latter having only three molar teeth in the lower jaw, and the former seven, whilst all the hyæna tribe have four.

Modern hyænas, when in captivity, eat up parts of their own bodies, especially their fore and hind feet and legs, by gnawing and sucking them. The monkey tribe also, when in confinement, are subject to a sort of itching, which induces them to nibble their extremities, especially their tails, so as ultimately to occasion mortification and death.

The Rhinoceros' Horn.

The Rhinoceros' horn is supposed by the Persians, Arabians, and other Asiatics, to sweat on the approach of poison, a quality which fitted it for being the drinking cup of an Eastern king. The emperor

Baber had one made into a drinking vessel and dice box.

The Mammoth.

The term mammoth (animal of the earth) has been applied to the fossil elephant by the natives of Siberia, who imagine the bones to belong to some huge animal now existing like a mole under the surface of the earth. The mammoth found entire in the isle of Tungusia was clothed with coarse tufty wool, of a reddish colour, interspersed with stiff black hair. It had a long mane on its neck and back, had its ears protected by tufts of hair, and was at least sixteen feet high.

ENTOMOLOGY, &c.

The natural history of insects; that branch of zoology which treats exclusively of insects.

Insects.

The bodies of insects are composed of joints and segments. All genuine insects have six legs, a head distinct from their body, and are furnished with two antennæ. They are all produced from eggs. Some undergo no metamorphosis, others but a partial change, while the remnant pass through three stages of existence, after emerging from the egg, for which purpose incubation is not necessary.

Metabolia—insects that undergo a metamorphosis.

Ametabolia—insects that do not undergo a metamorphosis.

No other animals but those of the insect tribe have more than two eyes. Some of these have four, as the phalangium; others, as the spider and scorpion, have eight eyes.

No organs for the circulation of the blood being provided in insects, respiration must be effected by means totally different from those of the higher classes of the animal creation.

Among invertebral animals, the power of flight is confined to insects with six feet.

Vermes (Worms).

This class comprehends all the annular ringed animals that have no distinct head.

Tribes of Insects.

1. Coleoptera—insects with sheathed wings, consisting of beetles, &c.; 4087 species.
2. Strepsiptera—of the genera xenos and stylops.
3. Dermaptera—earwigs.
4. Orthoptera—cockroaches, locusts, grasshoppers, crickets, mantes, &c.
5. Hemiptera—half-winged insects, such as bugs, water-scorpions, water-boatmen, leaf-lice, cochineal insects, &c.; 1427 species.
6. Trichoptera—consisting of flies produced by various species of case-worms, phryganea, &c.
7. Lepidoptera—scaled wings, such as butterflies, hawkmoths, and moths; 2570 species.
8. Neuroptera—nerved wings, such as dragon-flies, ant-lions, ephemeræ, &c.; 174 species.
9. Hymenoptera—membraneous wings, consisting of bees, wasps, and other insects, armed with a sting, or ovipositor, and its valves; 1265 species.
10. Diptera—two-winged insects, such as flies, gnats, &c.; 692 species.
11. Aphaniptera—wings not apparent, as the flea genus.
12. Aptera—without wings, such as mites, lice, &c.; 679 species.

Thirty years ago, the recorded number of insects amounted to about eleven thousand, but a great additional number has since been discovered and described; Humboldt says 44,000.

Changes of Form.

In general, insects undergo a material change in their form at stated periods of their lives. There are some, though few, such as the spider, &c. that burst forth from the egg completely formed, but the greater number exist in four different states, viz.

The first is that of the egg, whence the larva or

caterpillar is produced, which is the second stage. It is at first very minute, but in this state it feeds, some kinds on one or two plants, others promiscuously on many, continuing to increase in size, and moulting several times the outer skin, until the destined period of their dormant state approaches.

When this arrives, they spin a web more or less strong according to their species, and are converted into the aurelia or chrysalis, námed also pupa, from their swaddled appearance, which is the third stage; and, lastly, they burst forth in due season a perfectly formed winged insect, which is the fourth and last stage.

In this condition they propagate a future race, and perish themselves; for the males rarely survive the inclemency of the first winter, and the females of winged insects die after having deposited their eggs.*

The Ephemera.

This is the scientific name of the gnat, which ascends and descends over stagnant pools.

The Cells of Bees.

There are only three figures that will enable a carpenter to fill a certain space with cells, without losing any space between them, viz. the square, the equilateral triangle, and the figure of six sides. The last is the most convenient and strongest, having something the figure of the arch. A circle would be still stronger, but some room would be lost. The bees build their cells exactly in the six-sided form, and thereby save both space and materials.

* The larva of certain tipulæ and phalenæ inhabit the water, but when arrived at their winged state, are readily drowned if immersed in their original element. The larva of a carnivorous beetle moved briskly in a phial of strong alcohol the day after it was put in.

Bees.

A swarm of bees generally consists of one female, from 1000 to 1500 males, and of nearly 20,000 neuters, which are undeveloped females.

The Queen Bee.

We can by crossing vary the forms of cattle, but we have no means of altering the nature of an animal once born, a power undeniably possessed by bees. When the queen bee is lost, they choose a grub from among the working bees (which are all neutrals), they convert three cells into one, where they place the grub, and feed it with a peculiar food, tending it with extreme care. When transformed from the grub to the fly, it becomes not a working but a queen bee.

Life of Insects.

Among the insects, the male in some cases survives the process of generation; in others, the female only survives; while in many, death ensues on the egg being prepared and excluded.

The duration of life in the pedate annulosa, in their mature state, is limited in some to a few days, while in others it extends to many years.

Some of the zoophytes, as the corallina and spongia, exhibit no signs of sensibility, and but indistinct traces of irritability. The polypi of the sponges are unknown; the fibres appear to consist of a substance like coagulated albumen.

The Sphinx Atropos.

The caterpillars of the sphinx atropos, or death's head moth, are generally found in potatoe fields, feeding on the leaves. Some of these are from three to five inches long.

Sexes of Insects.

Worms are generally hermaphrodite. In insects, the male predominates; but the working bees and amazon ants are undeveloped females. Upon the whole, it appears that the male sex is the most numerous among animals, with the exception of the human race.

In quadrupeds, the males are larger than the females; while among insects, and even some birds, the females exceed the males in size.

From the division of our earth-worms six perfect ones have been procured, 213 days from the date of section.

The Musquetoe.

Although the musquetoe drenches itself with blood where it can get it, yet blood is evidently not its natural food, for it abounds in parts where there are neither beasts nor men to prey upon.

*Peculiarities of Insects.**

A humble bee will eat honey with greediness, although deprived of its abdomen; and an ant will walk when deprived of its head. The head of a wasp will attempt to bite after it is separated from the body; and the abdomen, under similar circumstances, if the finger be moved to it, will attempt to sting. What is still more extraordinary, the headless trunk of a male mantis has been known to unite itself with the other sex.

The Eyes of Insects.

The possibility of the functions of the eye being

* This note is from excellent authority, but appears rather marvellous. Modern writers on Entomology seem too prone to copy from the old Dutch and French naturalists, without verifying their assertions.

carried on, not merely without the presence of transparent humours, but by means of dark and solid parts as in the eyes of insects, is a fact at present quite unexplained.

Snails.

A gentleman cleaned and dried some snail-shells, and put them up in his cabinet. Many years afterwards he found the snails crawling about, and, on examination, it appeared that some water had got access and moistened the snails, so as to restore them to life.

The eyes of snails are lodged in their horns, one at the end of each horn, which they can retract at pleasure.

Spallanzani cut off the head and horns of snails by a sort of machine like a guillotine, and found they grew again.

The Boring Insect.

Mr. Osler thinks the saxica, or boring insect, as also some other animals, avail themselves of chemical as well as mechanical means by their uniform exertions on calcareous bodies, while their progress is arrested by siliceous bodies. The nature of the solvent (probably an acid) he could not discover.

Frogs.

It is said the frog does not reach its full size until five years old, and that it lives from ten to twelve years. In the winter it becomes torpid among the soft mud, or in cavities beneath the banks of stagnant waters, and is, like other reptiles, extremely tenacious of life.

Isaac Walton says, the mouth of the frog may be opened from the middle of April until August; then the frog's mouth grows up, and he continues so for at least six months without eating.

Frogs will live several days, although the brain be taken away.

The skin of a tadpole, after being pierced by the feet, forms, when dry, a kind of epidermis, and the tail is entirely absorbed.

Star-shot Jelly.

This is considered to be the glaire which surrounds the eggs of the frog, brought into this state by a frog having been swallowed by a bird, and the warmth and moisture of the stomach having made the jelly in the oviducts expand so much, that the bird is obliged to reject it by vomiting.

Live Toads in Stones.

The common food of the toad is small worms and insects of every description; but its favourite food is bees and wasps.

Spallanzani kept frogs, salamanders, and snakes, in a torpid state in an ice-house, where they remained three years and a half, yet readily revived when exposed to the influence of a warm atmosphere.

These experiments give countenance to the stories of toads being found enclosed in stones, a fact, however, which is not yet conclusively established. These animals may have entered the deep crevice of a rock, and during their torpidity been covered with sand, which afterwards concreted around them. In such a situation, it is impossible to fix limits to the period of their dormant state.

In general, when the temperature of the air sinks below 50° Fahrenheit, reptiles prepare for their winter slumbers.

Lizards.

The foot of a lizard, which runs on the roofs of rooms with its head and back downwards, is so con-

structed as to enable it to form a number of small concavities, which act like so many cupping-glasses or a boy's sucker, and the atmospheric pressure retains him in his position.

The foot of the common fly also is capable of forming the same concave vacuities, which enable it to proceed against the laws of gravity.

Poisonous Serpents.

Of forty-three kinds of serpents examined by Dr. Russel, only seven were found furnished with poisonous organs.

The Leech.

There is no outlet to the intestinal canal discovered in the common leech; mere transpiration is all that it performs, the matter oozing through, and fixing on the surface of the body, whence it afterwards separates in small threads.

If it be intended that the leech shall draw a large quantity of blood, the end of the tail is cut off, and it then sucks continually.

Leeches may be frozen stiff like pieces of ice, and easily re-animated, for a leech has no heart.

Three Hearts.

The poulpe, the seiche, and the calmar genera of the mollusca tribe, are provided with three hearts.

Shells.

The matter of the shell is secreted by the corium or skin of the insect, and the form it assumes is regulated by the body of the animal. It is coeval with its existence, and appears previous to the exclusion of the egg. The solid matter of the shell consists of common lime united with a small portion of animal matter resembling coagulated albumen. The mouth

of the shell is extended by the application of fresh layers of the shelly matter to the margin, and its thickness is increased by a coating on the inner surface.

Shell is hardened by carbonate of lime, bone by phosphate of lime.

Crabs.

Crabs have the power of parting with their claws by a voluntary effort, and have also the power of reproducing the whole limb; but, apparently, no provision has been made for the repair of injured parts, except by rejecting the whole claw, and having a totally new one produced.

The Nautilus.

The shell of the nautilus is formed of a number of chambers, the partitions of which are pierced through. The animal resides in the largest and last-formed chamber, and from it an elastic tube passes through the pierced septa, or divisions, and terminates in the first. With this tube it is supposed to exclude or admit the water, and thus raise or depress itself in the ocean at pleasure.*

The back of the nautilus-shell resembles a canoe; on this it throws itself, with two feet raised in the air, spreading over them a thin membrane for a sail, and paddling like oars with the other two feet.

The Polypus.

The polypus and puceron are singularly mis-named, for the first has no feet at all, and the second, so far

* The Nautilus family claims the very highest antiquity, being equally found in rocks of the oldest and newest formations, and having survived uninjured the debacles of half a dozen worlds. It might consequently be engrafted on coats of arms, as emblematic of the most extreme and indisputable antiquity.

from jumping and skipping like a flea, scarcely ever moves or walks.

The polypus can contract or extend its body at pleasure, from the length of an inch or more, and the thickness of a hog's bristle, to the shortness of a single line, with a proportional increase of thickness.

Reproduction.

Spallanzani carried the proofs of this power to their utmost limits, when he caused the head, with the tongue, jaws, and eyes, to be reproduced in a slug,—and the feet, with all their bones, muscles, nerves, and vessels, in the salamander.

This property, experimented upon in worms, presented Bonnet with several phenomena calculated to excite astonishment:—The anterior extremity, on being split, afforded two heads, which, yet scarcely formed, became enemies to each other. When the animal was cut into three distinct pieces, the middle piece commonly produced a head before and a tail behind. But a sort of mistake of nature sometimes occurred; the middle piece producing two tails, and being unable to nourish itself, soon ceased to exist.

Coral Worms.

Coral worms are of a great variety of shapes and sizes. The most common is the form of a star, with arms from four to six inches long; others are so sluggish as to be mistaken for a piece of the rock, and are generally of a dark colour, from four to five inches long, and two or three round. When the coral is broken about high water mark, it is a hard solid stone; but if any part of it is detached at a spot which the tide reaches every day, it is found to be full of worms, of different colours and lengths; some as fine as a thread, and several feet long;

others resembling snails, and not above two inches long.*

Marine Zoophytes.

The small polypi produce all those marine substances formerly called zoophytes, from a notion that they partook both of the animal and vegetable natures, including corals, corallines, madrepores, millepores, sponges, &c. It has been repeatedly found in the West Indies, that wrecks become wholly covered with madrepores and other corals, within three quarters of a year.

Sponge.

The true character of sponge is that of a living, inactive, gelatinous flesh, supported by innumerable cartilaginous or corneous fibres or spiculæ. The principal criterion of their animal nature is their odour in burning. No polypi are seen to issue from sponges, and the only sign of life they exhibit is a slight and hardly perceptible contraction and shrinking, when they are torn from their situation. After death, the animal jelly dissolves, and is removed, and the fibrous basis alone remains.

Ants.

Ants feed on both animal and vegetable substances, and, if left at liberty, will pick the bones of any dead animal, until they have rendered it a naked skeleton, by which expedient good skeletons of frogs, snakes,

* Are all, or any of these *coral worms?* This subject has as yet been but superficially investigated, considering its curiosity and importance. Whence do these minute creatures procure the inexhaustible store of calcareous matter for the construction of their enormous edifices, to which, in magnitude, the pyramids of Egypt are as grains of sand? Apparently, from the decomposition of the calcareous salts of the ocean; yet it is well known, the quantity of carbonate of lime in sea-water is trifling.

&c. have been obtained. Like bees and wasps, ants are divided into males, females, and neutrals, which last constitute the great mass of the tribe, and appear to conduct the business of the nest. They are probably undeveloped females.

The Food of Ants.

The principal food of ants is the honey that exudes from another insect in the grub state, which they bring home from day to day as they are wanted. Recent discoveries have proved that ants do not eat grain, but live almost entirely on animal food and this honey. Some kind of ants bring home the grubs, keep them in cells as cows are kept in stalls, feed them with proper vegetable matter, attend to their eggs, superintend the hatching, and rear the young like calves. When the cold renders the ant torpid, the insect becomes torpid also.

Invisible Animalcules.

The eye, unassisted, takes in from the elephant to the mite; but then commences the order of microscopal animals, which comprehends all those from the mite down to those estimated to be twenty-seven million times smaller; nor does the gradation actually stop here, being only limited by the imperfection of the microscope.* Nature is infinite in every thing; the heavens exhibit infinity of space, and the microscope infinity of animal diminution.

* There is a limit, however, to the power of high magnifiers. beyond which the liability to ocular deception becomes so great, as to counterbalance any supposed advantage from the increased magnitude of the object.

Infusoria. (Microscopic Animals discovered in Water.)

These are mere animated points, and appear to constitute the ultimate term of organization, nourished by absorption from the whole surface.

Animals of this class have no visible mouth, stomach, or internal vessels. They propagate by eggs, buds, and spontaneous division, and appear to subsist by decomposing water; and they themselves form a suitable repast for the annulose and molluscuous tribes, which tribes, in their turn, contribute to support the vertebral races. In both kingdoms (animal and vegetable) the smallest and most obscure species are subservient to the welfare of those that are larger and more perfect; and every species whatever must originate from the egg of a parent animal, for there is no such thing as spontaneous generation.

Vinegar Eels.

Mr. Montzelius asserts, he was so fortunate as to see vinegar eels undergo their last metamorphosis, and change into small flies; and it is highly probable, that the whole race of animalcules are the worm stage of some winged aerial insect, in all its stages invisible to the naked eye.

Spiders.

Spiders pass the winter in a torpid state, enclosed in their own webs. These insects ought not to be extirpated in stables, for there is a natural alliance between them and the horse. The more spiders' webs, the fewer flies.

ANATOMY, PHYSIOLOGY, AND MEDICINE.

ANATOMY is understood to treat solely of the structure of living beings, and Physiology solely of their functions.

The Skeleton.

The skeleton of the human body consists of 254 separate pieces of bone or osseous substances, most of which contain a quantity of matter called marrow, and are surrounded with a membrane called the periosteum. The height of the skeleton of a person five feet eight inches high when alive, will generally be found to be five feet seven inches.

The skeleton of a middle-sized man weighs $13\frac{1}{2}$ pounds, the usual weight of the brain is about $3\frac{1}{2}$, and that of the circulating blood 28 pounds. Total, 45 pounds, without muscles or intestines.

Animals' bones are composed of lime and phosphoric acid (phosphate of lime).

In the higher classes of animals, the bones are generally interior; but in the crustacea and testacea, (lobsters, oysters, &c.) they compose an external case, within which all the soft parts are contained.

The Embryon State.

An embryo is usually about twenty inches in length; average weight about . 7 pounds.
ditto of twins . 11

All quadrupeds, and mankind, in their embryon state, are aquatics.

The Brain or Cerebrum.

The brain weighs from two and a half to four pounds, and has no fixed relation to the weight or stature; indeed, it varies very little in individuals.

In man, the ratio of the weight of the brain to that of the whole body, has been stated on an average at about $\frac{1}{28}$th; in the dog, $\frac{1}{160}$th; in the horse, $\frac{1}{400}$th; and in the elephant, $\frac{1}{500}$th only; while, on the contrary, in several of the small singing birds, and particularly in the canary, the brain is above the average of man, being so much as $\frac{1}{14}$th. Among insects, the humble-bee has the largest brain, in proportion to the size of its body. In the radiata mollusca, the nervous matter appears to be disseminated among the different organs, and never appears in the form of a brain and its connecting filaments.

The Cerebellum, or Little Brain.

This is the lower or little brain, which occupies the lowest part of the encephalon, and weighs five or six ounces.

The developement of the cerebellum is simultaneous with that of the organs of generation at the age of puberty. Early emasculation prevents its developement, as well as of the beard, and organs of the voice.

Division of the Brain.

There is a dense membrane projecting directly downward to a considerable depth from the upper part of the skull, and extending from the fore to the back part of the head, which divides the brain into two hemispheres; the cerebellum is likewise divided by a similar membrane into two hemispheres.

The spinal chord or marrow has a longitudinal furrow dividing it imperfectly into halves, analogous to the hemispheres of the brain.

Brains not indispensable.

Acephalous fœtuses have grown to full size, and have even lived for some time after birth; and when they actually died, it did not appear to be owing to the want of brains, or to any physical impossibility of continuing life, but to the want of the organs of deglutition, which prevented their receiving a regular supply of nutriment.

Gall and Spurzheim's System of Phrenology.

According to Gall and Spurzheim, the various operations of sensation and volition are performed in particular parts of the brain, every faculty or feeling having a distinct organ in which it is generated. The fore part of the brain they consider subservient to intellect, the middle to sentiment, and the back part to propensities; a healthy brain being always understood.

The Nerves.

The nerves are medullary chords, differing from each other in size, colour, and consistence, and may be regarded either as originating from or terminating in the brain and spinal marrow. There are 39, sometimes 40, pairs of nerves, nine originating in the brain, and thirty or thirty-one in the spinal marrow, and the whole nervous system may be considered as a kind of net-work, between the different parts of which an intimate connexion subsists. The use of the nerves is to receive and convey impressions from all parts of the system to the brain, which more immediately exercises the powers of perception and volition; but the manner in which these operations are effected remains unknown. The whole forms what is called the nervous system, which connects us with the external world, and unites the different parts of the machine so as to form a definite whole.

The Optic Nerve.

If the optic nerves of an animal be divided, it becomes instantly blind, although the eyes remain untouched, and capable of acting on light as before.

Insects are the last in the scale of animated nature possessing eyes, and we have reason to suppose they see very obscurely.

Although old persons lose the power of distinguishing near objects, and require for this purpose convex glasses, they usually retain the sight of those that are distant as well as when they were young.

The Liver.

The weight of the liver, which in healthy subjects is about $3\frac{1}{2}$ pounds, in liver disorders sometimes increases to 18, and even 24 pounds.

The Ribs.

The ribs in general are 12 on each side, but in some 13, and in others, though rarely, only 11.

The Teeth.

At full maturity, we usually find 32 teeth in both jaws, viz. 16 above, and 16 below. The number varies in different subjects, but it is seldom seen to exceed 32, and is very rarely found to be less than 28 teeth.

Grinders above	10
Incisores, cutting, or front teeth	4
Canine or dog-teeth	2
Above . .	16
Below . .	16
	32

Among the wild animals, as old age increases, the teeth fall out, and the means of obtaining food thus failing, the body sinks to rest. Man is the only animal that can counteract the fatal consequences of the loss of teeth.

The Blood.

Haller estimates the blood at about one-fifth the weight of the adult body, which, in a person of middle size, may be reckoned about 28 pounds weight, three-fourths in the veins, and one-fourth in the arteries. Its temperature in the human subject is 98° Fahr.

Blood distends the cavities of the heart and blood-vessels, and prevents their collapsing; it also stimulates to contraction the cavities of the heart and vessels, by means of which the circulation of the blood is performed; it generates within itself animal heat, which it also propagates through the body; it nourishes the whole body, and is the source from which every secretion is separated.

In the higher classes of animals, the blood is of a red colour, florid in the arteries, and dingy in the veins. In the process of aeration, the blood parts with a portion of its carbon, which combines with a portion of the air inspired, and passes into the state of carbonic acid. The quantity of oxygen consumed by this process has been rated at 26, 38, and 36 cubic inches.

Circulation of the Blood.

Professor Blumenbach estimates that the heart expels two ounces of blood at each contraction, taking the number of pulsations at 75 per minute. The whole mass of blood be reckoned at 33 pounds.

Proceeding on these data, we shall find that the blood completes its circulation, the whole of it passing through the heart, in about 2½ minutes, and that

a mass of fluid equal to the blood would be carried through the heart 24 times in an hour.

By the pulsations, 1260 gallons of blood pass through the heart per day.

The Pulse.

By the circulation of the blood throughout the arteries, the particular motion called the pulse is created, it proceeding from the alternate dilatation of the arteries called diastole, and their contraction called systole. The time which the fibres of the arteries take to perform their systole (that is, returning to their natural state after their expansion,) is the distance between the two pulsations.

The average number of pulsations in an adult man in good health, between 30 and 40 years of age, is estimated about 73 or 75 in a minute; the pulse of females, of the same age and condition, is quicker, viz. about 84. In fever, a pulse of 120 indicates danger.

Blumenbach found the pulsations of the heart of a new-born infant, while placidly sleeping, amount to 140 per minute.

Towards the end of the first year	124
Second do.	110
Third do.	96
When the first teeth began to drop out	86
At puberty	80
Manhood	75
About 60	60

In those of more advanced ages, scarcely two were alike.

The Chinese Doctrine of Pulsation.

The Chinese are not at all convinced by the reasoning of the western nations, that pulses being

simultaneous in all parts of the body, the feeling of one pulse is therefore equal to the feeling of more than one, for they suppose that local disease may make a difference.

Involuntary Motion.

The organs of involuntary motion are those of digestion, circulation, and respiration. These go on continually, not being subject to intermission from exhaustion, as the voluntary are, which require repose and sleep to recruit themselves.

Vibrations.

Hartley explains the successive trains of thoughts, or association of ideas, by vibrations and vibratiuncles of the nerves, *parts that do not vibrate*, and which, if placed in any situation where they could be made to vibrate, would be no longer capable of transmitting sensation.

The Heart.

The essential difference as to the general structure of the heart, between amphibious and mere land animals, or such as never go into the water, is, that in the first the foramen ovale remains always open. Through this there is a communication, and the circulation is kept up, although the animal does not respire under the water.

The heart may be regarded merely as an enlargement of the veins.

The ventricle propels the blood through the pulmonic arteries, by which pulsation is occasioned.

Those vessels are termed arteries into which the ventricles of the heart discharge themselves.

The Eye.

There are two coats which may be considered as

constituting the integuments of the eye, and within which the other essential parts are contained. These are in the form of two cups, applied to each other at the margin, and hence the eye-ball approaches a globular form. The cup, which is situated with the convexity inwards, is termed the sclerotic coat. It determines the shape of the eye, and is perforated posteriorly for the passage of the optic nerve.

The central aperture, or transparent point on the retina, has been discovered in the eye of no other animals besides man, except in the quadrumana (apes, &c.), the axes of whose eyes are parallel to each other, and are like the human.

In the eyes of the cat, the choroides reflect, instead of absorbing, the rays of light.

Magnifiers of the Eye.

The eye is found to be composed of several natural magnifiers, which make a picture on a membrane at the back of it, and from this membrane a nerve goes to the brain, conveying the impressions of a picture, by means of which we become conscious of its existence.

The different natural magnifiers of the eye are combined on the same principle as the compound magnifiers of a telescope; the eye, in fact, consisting of different liquids which act naturally in correcting refraction and other imperfections.

The Hair.

The hair of the human head is always dark at the base, and continues so during the change to grey.

The peculiar colour of the hair is given to it by an oily matter.

Chyle.

Chyle is a close approximation to blood; it is de-

ficient only in colouring matter, and the albumen it contains differs a little from that existing in blood. From this it appears that the albumen is perfected, and the colouring matter formed, in the process of circulation. The saccharine principle of the chyle is then no longer perceptible.

Bile.

This secretion is formed in the stomach from venous blood.

Gastric Juice.

When there is no secretion of the gastric fluid, as during fevers, people live for weeks without food, one of its uses being to remind us, by its action on the coats of the stomach, that food is necessary.

There are some substances that remarkably resist the action of the gastric juice, such are the husks of grain, and many seeds, which, if not previously broken by mastication, pass through the stomach and bowels nearly unaltered. On this account birds have a gizzard, and animals that graze have flat teeth which grind and bruise their food.

The Stomach.

The stomach is not sensible of the weight, taste, odour, &c. of the substances received, and so far as it is concerned, we could not distinguish sugar from jalap, or wine from medicine. It is, however, the seat of feelings peculiar to itself, such as hunger, thirst, satiety, squeamishness, &c.

Conium maculatum, hyocyamus, euphorbium, and hellebore root, are poisons to man; while the first affords wholesome food to the cow and the hare, the second to the pig, the third to the goat, and the fourth to the quail.

A quantity of opium or arsenic that would destroy

a man, may be taken with impunity by a dog, which is more affected by a dose of jalap or nux vomica. Bitter almonds are poisonous to dogs and to various birds, while mountain-parsley is fatal to parrots.

Sympathy of the Brain and Stomach.

In man the brain is more sensitive than in other animals, and liable to be affected by various causes mental and corporeal. The digestive organs are in like manner deranged by stimulating and unnatural diet, while sedentary habits and impure air co-operate to aggravate these disorders. The affections of the brain and of the digestive organs mutually exasperate each other; and thus a state of constitution arises, productive of the most general and complex diseases. The disorder of the sensorium, excited and aggravated by the means described, frequently affects the mind. The operations of the intellect become enfeebled, perplexed, and perverted; the temper and disposition, irritable, unbenevolent, and desponding; and even the moral character and conduct appear liable to be influenced by these circumstances.*

Digestion.

The phenomena of digestion, as far as they can be traced, are as follow:—

The food is first conveyed to the stomach, where, by means of the gastric juice, it is converted into *chyme*. The chyme passes into the intestinal canal, where it is subjected to a new process, being gradually decomposed and converted into *chyle* and excrementitious matter, which by means of the bile are separated from each other. The last is evacuated, but

* Many cases of half insanity, now so common, are solely attributable to this cause.

the chyle is absorbed by the lacteals, and conveyed to the blood-vessels and lungs.

Various diseases may be resolved into mere sympathetic affections, connected with a deranged state of the organs of digestion. The intestinal canal forms an infinite number of windings and involutions through its course, measuring, on an average, six times the length of the individual.*

Corporeal Identity.

Some have considered a change of corporeal identity to be effected every three, others every seven years. Letters marked on the skin, however, last during life; and there are some diseases of which the constitution is only once susceptible.

Increase of Height at rising.

The cartilages between the vertebræ of the backbone, 24 in number, yield considerably to the pressure of the body in an erect posture, and expand themselves during the repose of the night; hence a person is considerably taller at his rising in the morning than at night. The difference in some amounts to so much as one inch; and recruits who have passed muster for soldiers in the morning, have been rejected when re-measured at night, as below the standard.

Respiration.

There are about 20 respirations made in a minute, and above 20 cubic inches of air are taken into the

* Boxers, by a certain plan of training, may be brought to attain a high degree of wind and muscular strength; but if they do not fight when at the height of their condition, a re-action takes place, and, although the same system be persevered in, they fall off below even their former average standard, and must live in their usual manner for some considerable time, before they can resume their training discipline with effect.

lungs at each respiration. For breathing freely, a man requires a gallon of atmospheric air per minute. Fifty-two pounds and a quarter avoirdupois are drawn in and thrown out of the lungs per diem, equal in bulk to 1,152,000 cubic inches.

The air in breathing loses its oxygen, and is replaced by an equal quantity of carbonic acid gas, which is ejected from the lungs at a temperature of about 90°.*

The condition of the organs of respiration and digestion appear so intimately connected with the comfortable continuance and attainment of old age, that existence may be said to depend on the due exercise of the functions they perform.

Amphibious Animals.

To enable an animal to exist equally in air and water, it should have lungs and gills, that is, it should have the power of breathing air like the mammalia and birds, and of breathing water like fishes, and it should be able to use either, to the exclusion of the other. But we know of no such animal.

Air Bladders.

Flat fish, which have no air-bladder, have great power in their pectoral fins, which enable them to strike the water from above downwards with considerable force.

Cod-sounds are the swimming-bladders of the large cod.

* Respiration is the principal cause of the developement of animal heat; assimilation, the motion of the blood, the friction of the various parts, produce the small remaining portion. Besides the oxygen employed in the production of carbonic acid, another portion disappears, possibly in assisting the combustion of the hydrogen of the blood.

Heat of the Human Body.

The heat of the human body is 96° or 97° of Fahrenheit; yet Sir Joseph Banks and Sir Charles Blagden actually breathed an atmosphere 52° higher than boiling water, viz. 264°. In this heat eggs were roasted in 20 minutes, and a beef-steak in 33 minutes was overdone.

The heat of metals at 120° is scarcely supportable, and water scalds at 150°; but air may be heated to 140°, without being painful to the organs of sensation.

Cold of the Human Body.

It is evident that the human frame is capable of supporting a more intense degree of cold than had been supposed possible before the publication of Captain Franklin's journey. During that expedition, it occurred that the individuals composing it were obliged to sleep in the woods, under the canopy of heaven, with no other covering at night than a blanket and deer-skin, with the thermometer frequently at minus 40°, once minus 57° below zero, (89 degrees below the freezing point,) while their bodies were greatly debilitated by the want of food (once for three days,) and their legs and feet were swelled and lacerated by snow-shoes.

Spontaneous Combustion.

There are instances of the spontaneous combustion of the human body by the rapid absorption of oxygen, so that the whole became silently reduced to ashes, independent of any external agent to which *the commencement of the combustion could be* attributed. These instances have always occurred to females addicted to spirituous liquors.

Vital and Chemical Affinity.

Organized bodies, animal and vegetable, are alone subject to putridity, to which inorganic substances are in no degree liable, the latter not being compounded according to the laws of vital affinity, but to those of chemical affinity. The resolution of pyrites (sulphuret of iron) in atmospheric air, is not putrefaction.

Elements of Animal Matter.

Carbon, hydrogen, oxygen, and nitrogen (or azote,) are the principal ultimate elements of animal matter; phosphorus and sulphur are also frequently contained in it. The presence of nitrogen constitutes the most striking peculiarity of animal, as compared with vegetable bodies; but as some vegetables contain nitrogen, so there are also certain animal principles into the composition of which it does not enter.

As vegetables abound in oxygen, they have a tendency after death to become acid, by its new combinations with carbon and hydrogen; whereas the soft parts of animals, after death, are disposed to become alkaline, the azote entering into new combinations with hydrogen, and forming ammonia.

Gouty Concretions.

There is a great analogy between urinary and gouty concretions. The latter have been discovered, by Dr. Wollaston, to consist of uric acid in combination with soda.

Colour.

The radical colours of the human family are independent of climate.

The result of a variety of dissections appears to have established the fact, that there is in the Negro, Caffre, and Malay, a black membrane interposed between the epidermis and true skin, upon which the

black colour of these tribes entirely depends. It does not exist in Europeans.

Stimulus.

To use the least quantity of stimulus that will preserve the body in healthy action, is an excellent maxim, applicable to the mind as well as to the body. Every excitement has its consequent lassitude and languor.

Scent.

Scent in hunting depends chiefly on two things, the condition of the ground, and the temperature of the air, which should be moist without being wet. When both are in this state, the scent is said to be perfect. When the ground is hard and dry, there will scarcely be any scent, and it hardly ever lies with a north or an east wind. A southerly wind without rain, and a westerly one that is not rough, are the best; a day warm without sun is a perfect one. In some fogs the scent lies high; in others not at all.

On the nicest examination, no proof has ever been found of a hare's sweating, any more than a cat or dog.

Specifics.

The example of Cinchona in intermittents, and of mercury in syphilis, show that there are in nature substances with specific powers. But be it remembered that the experience of more than 3000 years has only discovered these two, and even the first still doubtful, unless to these we add the use of sulphur for the itch. Their operation, also, is so utterly inexplicable, that their effect may be regarded as a species of miracle.

Antidotes.

The progress of knowledge has demonstrated that there are no such things as antidotes against poison, and never were.

Calomel.

In a case of cholera morbus, in the East Indies, 130 grains of calomel were given to a patient in the course of an hour, without the slightest effect.

Opium.

By the common estimate, twenty-five drops of laudanum are equivalent to one grain of opium. A small tea-spoon holds about 100 drops of laudanum.

In one case of hydrophobia, 180 grains of opium were administered without any benefit, and without producing any sleep.

Croton Oil.

One drop of croton oil merely applied to the tongue will produce purgative effects. There are ninety species of croton plants, but only one that is purgative.

Average annual Sickness.

The average annual sickness of an individual, as calculated in 1824, from the records of seventy benefit societies in Scotland, and comprising the experience of 7000 persons, was as follows:—

Age.	Sickness in weeks and decimals of a week.
Under 20	0·3797
20 to 30	0·5916
30 to 40	0·6865
40 to 50	1·0274
50 to 60	1·8806
60 to 70	5·6337
Above 70	16·5417

The total average sickness experienced by a person who attains the age of seventy, during fifty years, from 20 to 70, is about ninety-eight weeks.

Corpulence.

Animal fat is oil concreted by a peculiar acid, named the sebacic, and is concrete in proportion to the predominance of the acid.*

Fat meat, butter, oil, and more especially spirituous liquors, are hydrogenous foods; acids of all sorts are, of course, oxygenous foods.

Consumption.

Tabes maxime contingunt ab anno decimo-octavo ad trigintum-quintum.

Consumptions generally take place between the eighteenth and thirty-fifth year.

Small-Pox.

More persons have died of the small-pox, since the introduction of inoculation, than before that period. In Great Britain, about 45,000, or 95 in the thousand.

Vaccination.

On the 14th May, 1796, Dr. Edward Jenner, of Berkley, near Gloucester, first applied to the arm of a healthy boy of eight years, the morbid fluid secreted by a sore on the hand of a dairy-maid, who had contracted cow-pock from the udders of her master's cows.

In most parts of the continent of Europe, vaccination has been ordered by the governments, no one who has not undergone either the cow or small-pox being allowed either to be confirmed, placed at school, apprenticed, or married.

Mortality.

The rate of mortality since the time of Boerhaave has decreased nearly one-third, referrible to the more

* Cannot some method of neutralizing this acid be discovered?

temperate habits that prevail through all ranks of society, to the entire disappearance and mitigated severity of many diseases, and to the substitution of vaccination for the small-pox.

Dr. Young allows that of late years, whether from vaccination, increase of comforts, temperance, or improvements in medicine and surgery, a decided increase in the mean duration of life has taken place throughout Europe.*

The Nosology of Brutes.

A monkey at Amsterdam contracted a local ulcer from the small-pox, but had no fever.

A very great proportion of diseases, and all mental affections, may be considered as peculiar to man, brutes being exempted from their influence.

Leprosy.

The leprosy and land-scurvy became gradually extinct in England, when the reformation in religion, and improvements in agriculture, had removed the necessity of eating salt fish and salted meat during a great portion of the year

Contagion.

Although the matter of contagion is a chemical compound, which may be preserved for a great length of time unchanged, no method of subjecting it to chemical analysis has yet been discovered.

Embalming.

The antiseptic powder used in this process appears to have been composed of two parts camphor, one of

* What has been the result of this increase, which many superficial writers appear to think an unmixed good?—we are now suffering all the miseries incident to a redundant and starving population; all the calamities of (what is called) prosperity.

resin, one of nitre, and a sprinkling of rosemary and lavender.

Drops.

It is not uncommon in medicine to prescribe so many drops, yet not only do drops of fluids from the same vessel, and often of the same fluids from different vessels, differ in size, but also drops of the same fluid, to the extent of a third, from different parts of the lip of the same vessel.

Gluttony.

An Esquimaux can devour four or five pounds of blubber at a sitting, and at least ten in the course of a day. During Captain Parry's second voyage, it was tried, as a matter of curiosity, how much a full-grown Esquimaux lad would, if freely supplied, consume. The articles mentioned below were weighed before they were given to him; he was twenty-four hours in getting through them, suffered no subsequent inconvenience, and certainly did not consider the quantity extraordinary.

	lbs.	oz.
Sea-horse flesh (or blubber), raw and hard frozen .	4	4
Ditto ditto boiled	4	4
Bread and bread-dust	1	12
Total .	10	4

The fluids were in fair proportion, viz.

Rich gravy-soup . .	1¼ pint.
Raw spirits . . .	3 wine glasses.
Strong grog . . .	1 tumbler.
Water	1 gallon and 1 pint.

Another Esquimaux, who visited Captain Lyon,

began at two o'clock P.M. and by eight o'clock A.M. on the following day, had swallowed as follows:

	lbs.	oz.
Bread-dust and train-oil . . .	1	10
Walrus flesh, boiled	7	1
Seal and bread	1	0
Two candles	0	3
Bread and butter	0	1
Total solids .	9	15

Fluids:—

Rich walrus soup	2 quarts.
Water, above	4
Total fluids .	6 quarts.*

* No medical professor has ever attempted to account for the extraordinary powers of digestion these savages appear to possess, as in summer time, when food was plenty, ten pounds of seal and walrus flesh, boiled and raw, per day, was reckoned no extravagant allowance for a man in health.

OPTICS (ὀπτική).

The science of the nature and laws of vision, a mixed mathematical science, which includes catoptrics, dioptrics and perspective, and considers the nature, composition, and motion of light.

Seeing a Star when not looking at it.

By directing the eye to *another part* of the field of a telescope, a faint star, in the neighbourhood of a large one, will often become very conspicuous, and yet totally disappear if the eye be turned full upon it.

The Retina.

An impression on the retina continues for about the eighth part of a second after the object that produced it is withdrawn. Thus the luminous ring formed by whirling a burning stick.

Intense Light.

After the trial of various pyrotechnical preparations, Lord Drummond was led to adopt a ball of lime intensely ignited, and placed in the focus of a parabolic mirror. The intensity of the light from the ball is about 75 times greater than that of an Argand lamp. It was used on the survey of the coast of Ireland.

Microscopes.

To determine the magnifying power of glasses employed in single microscopes.

If the focus of a convex lens be at one inch, and the natural sight at eight inches, which is the common standard, an object may be seen through that line at one inch distant from the eye, and will appear in its diameter eight times larger than to the naked eye.

But as the object is magnified every way equally, in length as well as in breadth, we must square this diameter to know how much it in reality appears enlarged; we shall then find that its superficies is magnified 64 times.

A small globe of glass, or of any transparent substance, makes a microscope.

Invisible Rays.

Sir William Herschel discovered invisible rays beyond the red extremity of the spectrum, which have the power of heating, but not of *illuminating*, objects. This led to the subsequent discovery of the chemical or de-oxidating rays, at the opposite side of the spectrum.

The colour of white is a mixture of all the other coloured rays.

Magnifying Power.

The magnifying power of reflecting telescopes may be increased merely by varying the distance between the eye-piece and the great speculum, and then producing distinct vision by the new adjustment of the small mirror.

Strength of Sight.

There is reason to believe that a good eye in the prime of life, and unaided by glasses, may see an

object under an angle not exceeding half a minute of a degree.

Sir William Herschel's Telescope.

The speculum of Sir William Herschel's 45 feet telescope was 49½ inches in diameter, 3½ inches in thickness, and weighed, when newly cast, 2118 pounds. It magnified 6450 times, and was completed on the 27th August, 1789.

GRAMMAR, &c.

THE science of speaking correctly. The art which teaches the relations of words to each other.

Words.

Dr. Johnson's Dictionary contains the following, but they are by no means the whole in the English language:—

Articles			3
Nouns substantive			20,410
Adjectives			9,053
Pronouns			41
Verbs			7,880
Participles			38
Participal	Adjectives	125	128
	Nouns	3	
Adverbs		496	2,592
Do. in *ly*		2096	
Prepositions			69
Conjunctions			19
Interjections			68
		Total	40,301

The Preposition.

As the necessity of the *article* (or some equivalent invention) follows from the impossibility of having in language a distinct name, or *particular term*, for

each particular individual idea; so does the necessity of the *preposition* (or some equivalent invention) follow, from the impossibility of having in language a distinct *complex term* for each different *collection of ideas*, which we may have occasion to put together in discourse.

To supply, therefore, the place of the complex terms which are wanting in a language, the preposition is employed. For having occasion to mention a collection of ideas, for which there is no single *complex term* in the language, we either take up that complex term which includes the greatest number, though not *all*, of the ideas we would communicate; or else we take that complex term which includes *all*, and the fewest ideas more than those we would communicate; after which, by the help of the preposition, we either make up the deficiency in the one case, or retrench the superfluity in the other. For instance—

1. "A house with a party-wall."
2. "A house without a roof."

In the first instance the complex term is deficient, and the preposition directs to add what is wanting. In the second instance the complex term is redundant, and the preposition directs to take away what is superfluous.

Collectives.

Nouns of number, or collectives, may have a singular or plural verb, though themselves be singular; as, the mob *is* or *are* unruly; the parliament *is* or *are* sitting; part of the army *was* or *were* slain.

Particles.

Wherever the evident meaning and origin of the particles of a language are to be found, *there* is the certain origin of the whole.

Horne Tooke's Derivation of Conjunctions.

If, is the imperative of		Giffan . .	To give.
An . .	ditto .	Anan . .	To grant.
Unless .	ditto .	Onlessan .	To dismiss.
Eke .	ditto .	Eacan . .	To add.
Yet .	ditto .	Getan . .	To get.
Still .	ditto .	Stellan . .	To put.
Else .	ditto .	Alessan .	To dismiss.
Though	ditto .	Thaffigan .	To allow.
But . .	ditto .	Botan . .	To boot.
But . .	ditto .	Beon-utan	To be out.
Without	ditto .	Wurthan-utan	To be out.
And .	ditto .	Anandat .	Dare congeriem.
Lest is the past participle Lessed of		Lessan .	To dismiss.
Since is the partic. of		Seon . .	To see.
That is the pronoun		That . .	Allow.

Welsh Pronunciation.

Welsh.	English.	Welsh.	English.
C . .	as K	ff .	as f
Da or Z	as Th	Ll .	as Ill or L aspirated.
F . .	as V	U .	as i (in bliss.)
W .	as oo	Y .	as u (in burn.)

Welsh Words.

Caer or Gaer .	A fort.
Coed	A wood.
Gwyn	White.
Llan	A church, an inclosed place.
Mawr	Great.
Uwch	Upper.
Ys	Lower.
Y	Of, on.
Dwr, Dr . .	Water.
Myndd	A mountain.
Pen	A head, top.

Ty	A house.
Cwm . . .	A deep valley.
Du or Dee . .	Black.
Eglwys . . .	A church.
Tre, Tref . .	A house, village.
Yr	The.

Aber, a British word for the fall of one stream or rivulet into another, junction, confluence, &c., as Aber-deen.

Celtic Languages.

The Celtic languages differ from the Greek and Latin, in having no cases to their nouns, nor passive verbs, in the common use of auxiliary verbs, as well as in many other points.

Language of the Incas.

The language called the Quichan, or language of the Incas, is said to be harmonious, although the sounds B. D. F. G. and R. are wanting.

Punctuation.

Punctuation is a modern art, for the ancients were entirely unacquainted with the use of our commas, colons, &c., and wrote not only without any distinction of chapters, sections, members, or periods, but also without distinction of words. In ancient Greek manuscripts, the whole discourse seems written with one stroke of the pen, the words and letters being joined throughout. This practice Lipsius thinks continued until the 104th Olympiad, up to which time the sense alone divided the discourse.

The Conjunction disjunctive.

Two or more nouns, &c. in the singular number, joined together by one or more copulative conjunctions, expressed or understood, must have verbs,

nouns, and pronouns agreeing with them in the plural number. The conjunction disjunctive (*or*), however, has an effect contrary to that of the conjunction copulative; for as the verb, noun, or pronoun, is referred to the preceding terms, taken separately, it must be in the singular number.

Nouns of Multitude.

A noun of multitude may have a verb or pronoun agreeing with it, either in the singular or plural number; but not without regard to the import of the word as conveying unity or plurality of idea. In the application of this rule, we ought to consider whether the term immediately suggests the idea of the number it represents, or whether it exhibits to the mind the idea of the whole as one thing. In the former case, the verb ought to be plural; in the latter, singular.

The English Genitive.

The English genitive has often an unpleasant sound, so that we make more use of the particle *of* to express the same relation. In some cases we use both the genitive termination and the particle *of;* as, " it is a discovery of Sir Isaac Newton's." Except, however, to prevent ambiguity, this double genitive seems only allowable in cases which suppose the existence of a plurality of subjects of the same kind, as, " a vassal of the emperor's." If practicable, it would be better to avoid this double genitive altogether, and give the sentence another form of expression.

Cases and Prepositions.

The ancients employed cases to express the varieties of relation, which in modern tongues are denoted by prepositions. Hence the gradual substitution in the languages of modern Europe, of prepositions in-

stead of declensions, and of the substantive and possessive verbs (am and have) instead of conjugations.

Doubling the Consonant.

Words of one syllable, or at most two (and then having the accent on the last syllable), ending in a single consonant preceded by a single vowel, in forming an additional syllable, double the consonant; as, pat, patting; bed, bedding; impel, impelling, &c.

Synonomy.

The primitive or etymological idea expressed by any two words, may, from the time of their introduction, continue to be the primary conception attached to each; but in the changes and modifications to which all living languages are subject, an accessory idea may be associated with one of these, which is not attached to the other.

Terms of Science.

It is doubtful whether the innovations in the terms of science always repay us, by their superior precision, for the uncertainty and confusion they occasion.

The period is probably not very remote when this mischievous* spirit of innovation shall receive an effectual check, in consequence of credit being attached to those who develope new characters, and not to those who disturb science by the fabrication of unnecessary names.

Writing in Cypher.

A cypher, consisting of nine radical characters (those, for instance, composing the well known figure # with one, two, three, or more points, at pleasure, above, below, or in the body of the figure,) is sufficient to compose a great enough variety of secret symbols for any purpose.

Memoria Technica.

Dr. Grey's plan was to make such a change in the termination of the name of place, person, coin, planet, &c. &c., without altering the beginning, as shall readily suggest the thing sought, while the beginning of the word being preserved, it becomes a leading or prompting syllable to the end of the word thus changed. As Cyruts, Alexita, Julios (for Cyrus, Alexander, and Julius), the final letters of which suggest the year of the world in which they lived, and some other particulars.*

A Universal Language.

This is formed by Arabic numbers taken arbitrarily. Every number is assumed as denoting the same word in *all languages.* By means of this distinction, when a Frenchman is desirous of writing to a German the following sentence, *la guerre est un grand mal,* he seeks in his index for *guerre, être, grand, mal,* and writes the correspondent numbers, 13. 33. 67. 68.

* The labour of acquiring this system is so great, and the benefit resulting so unimportant, that it has been compared to cracking nuts with a steam-engine.

GENERAL LITERATURE, &c.

Letters.

The servile letters are the vowels A, E, I, O, U; the digamma, V or B; the liquid, M, N, R; the aspirate, S; and the mute, T. All the additions and variations to any primitive or radical word, serving to distinguish the different circumstances of time, number, sex, manner, &c., are made by them.

Printing.

The first book printed in the English language was Wyllyam Caxton's Recuyel of the Historyes of Troy, by Raoul le Feure, folio. Colen, 1471. A copy of this work, which formerly belonged to Elizabeth Gray, Edward the 4th's Queen, was bought from the Roxburgh collection by the Duke of Devonshire, for £1060. 18*s.*

The annals of Typography begin with the Codex of 1457; but the secular feast in memory of the invention of printing, in the 40th year of the century (1440). If this tradition be right, the art, in 1457, had been already exercised seventeen years.

The Digamma.

The Greek Digamma is oriental in its form and power. It is the Phœnician, or rather the Hebrew ו or V, which turned from the left to the right, according to the European manner of writing and reading, resembles the Γ (g) or gamma of the Greeks; and therefore placing one on the top of the other

thus, F was called *di*, or double gamma. This letter is retained in the Latin alphabet. The sound of this letter, so often to be supplied, and so rarely expressed in Greek, is by Gattaker and others supposed to be the sound of W.

Pronunciation.

The Chinese are incapable of articulating many of the sounds uttered by other nations; Russia, for example, they pronounce *Golosee.*

Greek, Hebrew, and Phœnician Characters.

Invert the Greek characters from left to right, according to the Phœnician and Hebrew manner, and they are nearly the same, as also in name, for which see the 19th Psalm.

The mode of writing from the right hand to the left, appears originally to have obtained among the Greeks. Afterwards they adopted a new method of writing the lines alternately from the right to the left, and from the left to the right, which was called Boustrophedon, or writing after the manner in which oxen plough the ground.

Utterance.

Gibbon inquired of a short-hand writer, at Mr. Hastings' trial, how many words a ready and rapid speaker might pronounce in an hour; from 7000 to 7500 was the answer. Suppose the average to be 7200, this will be at the rate of two words per second, and 120 per minute.

Speaking.

From what cause does it happen, that a good speaker no sooner conceives what he would express,

than the letters, syllables, and words, arrange themselves according to innumerable rules of speech, while he never thinks of these rules. He does all this as it were by inspiration, without thinking of any of these rules, or breaking any of them.

To some men and women, the incessant exercise of speech seems no less necessary than the function of respiration; and to such persons, while indulging this incontrollable propensity, the entertainment of their hearers is not at all an object,—it is sufficient that they can obtain patient listeners.

Hand-writing.

The specific differences that mark hand-writings.—In this particular, *the general effect in character*, which the object presents to the practised eye of a man of business, is a much more infallible criterion of identity, than a precise resemblance in a few prominent details. A banker's clerk will discover a forgery with much more certainty than a writing-master or engraver.*

English Names.

Camden says, that there is not a village in Normandy, but gives its name to some family in England, such as Mortimer, Warren, Albigny, Piercy, Devereux, Tankerville, Nevil, Tracy, Montfort, &c. &c.

Latin.

The bulk and foundation of the Latin language is the Greek, but a considerable portion of it is the language of our northern ancestors grafted on the

* Hand-writing indicates, to a certain degree, the character and temperament of the individual, whether impetuous, or cool and deliberate,—confused or clear. This does not apply to the modern hand-writings of ladies, which are all exactly alike.

Greek, to which source etymologists must go for that part of the Latin which the Greek will not furnish.

Roman Names.

Every free Roman had three names, the nomen, prænomen, and the cognomen. The nomen was the family or surname, as Scipio; the prænomen answered to our font or baptismal name, as Cornelius; and the cognomen was added from some incidental circumstance, or to mark some particular branch of the family, as Publius. To these a fourth was sometimes added as an honourable distinction, such as Africanus.

Augustus.

The Greeks rendered the name of Augustus by ΣΕΒΑΣΤΟΣ (Sebastos), and gave it to all his successors, after the example of the Romans. Hence Sebastopolis, which occurs so frequently as the name of cities.

Theory.

When the mind is intoxicated with a theory, it eagerly grasps at every shadow of evidence that seems to favour it, and it is generally the first dupe of the system it has created.

Controversy.

In conducting a controversy, the following rules ought to be observed:—

1. The terms to be clearly explained.
2. Phrases of self-sufficiency to be avoided.
3. Personal reflections prevent just reasoning.
4. The adversary must not be accused of indirect motives; his arguments must be answered, whether sincere or not.

5. The consequences of any doctrine are not to be charged to those who hold those doctrines.

6. It is improper to refer any saying of an adversary to a party.

Lord Bacon's Arrangement.

History.—To comprehend all knowledge of particular facts and events.

Philosophy.—To comprehend all general conclusions or laws, inferred from these particulars by induction.

Poetry.—All the arts addressed to the imagination.

Induction.

Induction is, when from several particular propositions we infer one general rule.

It is the business of philosophy to explain detached phenomena, by referring them to general laws.

The Instantia Crucis.

When in any investigation the mind is placed in equilibrio between two causes, nothing remains to be done but to look for a fact, which can be explained by only one of the causes, which last must then be considered as the true cause. Such facts perform the operation of a cross, erected at the separation of two roads, on which account Lord Bacon gave them the name of the instantiæ crucis.

Classification.

The characters of the class comprehend all the properties common to its orders, genera, and species.

The characters of the order will include all the properties common to its genera and species.

The characters of the genus will include all the properties common to the species.

And in the description of a species, it will only be necessary to enumerate those modifications of character which constitute the peculiarities of the vital principle.

In zoology, species alone are permanent, all the others being subject to change.

Eras.

The practice of counting by the years of our Christ, was only introduced into Italy during the sixth century; and in the north of Europe, towards the eighth century, under Charlemagne, the Gregorian reformation of the Calendar took place on the 4th of October, 1582; the reform of the calendar in England, on the 29th of March, 1752.

Confucius.

Confucius lived about five hundred years before the Christian era, near the age of Cyrus, Pythagoras, and Solon; about 1000 years after Moses, and 500 after King David.

Hypothesis.

These are sometimes of great utility in assisting us to generalize and retain in the memory a number of particular facts, which would otherwise be insulated.

Imputations.

The imputation of unavowed intentions to an adversary is not only one of the most vulgar, but also one of the most dangerous arts of controversy.

What private individuals write should not be im-

puted to the doctrine of any particular sect, or to the prejudice of any man who does not hold it.

Calumny.

Calumniari est—Falsa crimina intendere. To accuse of false crimes.

Prævaricari est—Vera crimina abscondere. To conceal true crimes.

Tergiversatur—Qui universum ab accusatione desistit. To desist from the whole accusation.

Tobacco.

The Haytian word Tobacco appears to be the only one that is the same in all the dialects of the Old World.

The Burning of Widows.

According to the Brahminical tenets, a widow who burns secures for herself and husband enjoyments in Paradise for as many millions of years as there are hairs on the human body, that is to say, thirty-five millions. This text is attributed to Angiras, and forms part of the declaration, or Sancapa, pronounced by a widow at the time of her ascending the pile.

Burmese Females.

An intelligent officer says,—"Notwithstanding the cruelty and sanguinary disposition of the Burmese during war, in his private and domestic habits he evinces little of that ferocious arrogance which renders him the terror of surrounding nations. At home he is lazy and averse to work, compelling his wife to toil worse than a beast of burthen, while he passes his time in idleness, smoking and chewing betel. His wants are few and simple; rice, and a little pickled or putrid fish, forms his repast; water his drink; and he seems happy and contented, bearing all kinds of

oppression with apathy and indifference, and kind to every body but his wife and daughter, *both of whom he works like slaves, and prostitutes for money to strangers.**

Stages of Life.

The ancients reckoned six stages of life, viz.

Pueritia—Childhood, to the fifth year.

Adolescentia †—Youth, to the 18th year, and youth properly so called, to the 25th year.

Juventus—From the 25th to the 35th year.

Virilis ætas—Manhood from the 35th to the 50th year.

Senectus—Old age, from the 50th to the 60th year.

Crepita ætas—Decrepid age, which ends with death.

False Principles.

It is impossible, by correct reasoning from false principles, to bring out true conclusions.

Ad Hominem.

In logic, this is a kind of *argument* drawn from the principles or prejudices of those with whom we argue.

Taste.

The words good, fine, magnificent, bad, ugly, &c. equivocal in themselves, ought always to be understood with reference to the taste of the individual.

The Horizon of the Understanding.

Were the capacities of our understanding well considered, the extent of our knowledge once disco-

* In certain stages of society, the misery of the female sex is so deplorable, that any change or transfer would apparently be an improvement in their condition.

† Adolescentia is completed when the body has attained its full height.

vered, and the horizon found which sets the bounds between the enlightened and dark part of things, between what is and what is not comprehensible by us, we should not then be vainly urging our intellect beyond the mysterious and impassable barriers of the human mind.*

Originality.

In books that best deserve the name of original, there is little new beyond the disposition of the materials already provided; the same ideas, and combination of ideas, have long been in possession of other hands.

Absurdity.

Voltaire could hit the absurdity of opinion, but not of character, on which account, with all his wit, he never succeeded in writing comedy.

The Magical Square.

The Chinese have discovered mystical letters on the back of the tortoise, which is the common magical square, making 15 each way, viz.

2	9	4
7	5	3
6	1	8

* Nature has endowed man with faculties fitted to observe the phenomena as they at present exist, but has denied the power to discover the beginning, or the end, or the essence of any thing.

MUSIC, &c.

The science of harmonical sounds; instrumental or vocal harmony.

The Musical Signs.

The seven musical signs, ut, re, mi, fa, sol, la, sa, invented by the Benedictine monk Guido Aretino, are the first syllables of some words contained in the first strophe of a Latin hymn, composed in honour of St. John the Baptist, which runs thus:—

Ut queant laxis, *Fa*muli tuorum
*Mi*ra gestorum *La*biis reatum
*Sol*ve pollutis *Sa*nte Joannes.
*Re*sonare fibris

Octaves and Concord.

When two strings, whose length is as one to two, vibrate together, it is obvious that the one vibrates twice, while the other only vibrates once; they will coincide at the beginning of every alternate vibration, and their sounds will then accord. When the strings are in this proportion, their coincidences are more frequent than when their lengths are in any other ratio, and hence it is that the octave is the most perfect concord.

If the lengths be two to three, which is the ratio of the fifth, every third vibration of the one coincides with every second of the other; the coincidences are consequently not so frequent as in the octaves, on which account the concord is not so frequent.

Discord.

If their lengths be such that they never describe the arcs of vibration together, but perpetually cross each other in their oscillations, then their sounds are jarring and unconsentaneous, and thus discord is produced.

Scottish Music.

The Scottish airs of genuine character are composed on a scale which does not contain the fourth and seventh of the diatonic scale of music. From this is derived the peculiarity by which they are immediately recognized.

Beating Time.

An attentive person can beat time pretty accurately for one minute, but it is very difficult to be correct for a greater length of time.

Stammering.

A drunken man, or a person afflicted with St. Vitus's dance, can run, although he cannot walk or stand still. In the same manner, a stammerer can sing, which is *continuous* motion, although he cannot speak, which is *interrupted* motion.

Musical Figures resulting from Sounds.

Cover the mouth of a wide glass having a foot-stalk with a thin sheet of membrane or vegetable paper, over which scatter a layer of fine sand. The vibrations excited in the air by the sound of a musical instrument held within a few inches of the membrane, will cause the sand on its surface to form regular lines and figures with astonishing celerity, which vary with the sound produced, affecting a particular mode of division according to the number of vibrations.

*Singing Birds.**

The following table, formed by the Honourable Daines Barrington, is designed to exhibit the comparative merit of the British singing birds. In this scale, *twenty* is supposed to be the point of absolute perfection.

	Mellowness of tone.	Sprightly Notes.	Plaintive Note.	Compass.	Execution.
Nightingale . . .	19	14	19	19	19
Skylark	4	19	4	18	18
Woodlark	18	4	17	12	8
Titlark	12	12	12	12	12
Linnet	12	16	12	16	18
Goldfinch . . .	4	19	4	12	12
Chaffinch . . .	4	12	4	8	8
Greenfinch . . .	4	4	4	4	6
Hedgesparrow . .	6	0	6	4	4
Aberdavine, or Fiskin	2	4	0	4	4
Redpoll	0	4	0	4	4
Thrush†	4	4	4	4	2
Blackbird . . .	4	4	0	2	4
Robin	6	16	12	12	12
Wren	0	12	0	4	2
Red-sparrow . .	0	4	0	2	4
Blackcap, or Norfolk Mock Nightingale	14	12	12	14	14

* Mr. Blackwall, in opposition to the Honourable Daines Barrington, considers the notes of birds to be instinctive, and not depending on the master under whom they are bred.

† The thrush does not appear to have his proper rank in this scale.

Sound.

All sound travels at the same rate, (1142 feet per second, or thirteen miles per minute,) a whisper, as far as it goes, as fast as the report of a cannon. It also describes equal spaces in equal times.

The strength of sound is greatest in cold and dense air, and least in that which is warm and rarefied. During Captain Parry's first voyage, in lat. 74° 30′ N., people might often be heard conversing distinctly, in a common tone of voice, at the distance of one mile.

At Port Bowen, during Captain Parry's third voyage, it was found two persons could keep up a conversation with great facility between two stations at the measured distance of 6696 feet, or about $1\frac{1}{5}$ statute miles. The thermometer at 18° below zero, or 50° below the freezing point.

Sound through Solid Bodies.

A shock so slight as that produced by the head of a pin struck against one end of a long beam, is distinctly transmitted to the other end; indeed vibrating motions may be propagated along the substance of solid bodies to an immense extent.*

Uncertainty of Sound.

In listening to sounds, we are deceived as to the quarter from whence they proceed, by the change produced in the direction of the sonorous waves by intervening obstacles, so that we mistake the reflected for the radiated vibrations, echo for direct sound.

* It is probable that a smart blow on one end of a solid bar of iron, of two inches in diameter and ten miles long, would be heard almost instantaneously at the other extremity; but for the success of such an experiment it would probably require the climate and silence of Melville Island.

Musical Flame.

Musical tones are produced by the combustion of hydrogen gas in tubes of different diameters.*

* Music, by the ideas it recalls, assists in preserving the chain of our mental identity.

THE FINE ARTS, &c.

The Durability of Sculpture.

The durability of substances employed for sculpture and architecture, is not in proportion to their hardness. Marble, although considerably softer than granite, is able to resist much longer the combined attacks of air and moisture. Of all substances used by the ancient artists, Parian marble, when without veins and consequently free from extraneous substances, seems best to have resisted the operations of time and violence, it being found unaltered when granite, and even porphyry, coeval as to their artificial state, have suffered decomposition.

Bath freestone has been employed in the late repairs of Henry the Seventh's chapel at Westminster.

St. Paul's cathedral was principally built of stone procured from quarries about a mile north from Burford, in Oxfordshire.

Terra cotta is still more durable than marble. Works executed in baked clay have been preserved during a period of 3000 years as fresh as when issued from the hands of the artificer.

The Duration of Pictures.

The duration of a picture does not depend on the strength or durability of the canvass on which it is painted. The canvass may be renewed as often as may be found necessary, and the colours will in time become as hard and as durable as enamel. It is by frequent and injudicious cleaning that pictures are destroyed.

Durability of Granite.

Some granites resist for ages the destroying efforts of the weather, while others are resolved into sand and clay in a comparatively short period. The obelisk at the Place de St. Jean de Lateran, at Rome, was quarried at Syene, under the reign of Zetus, king of Thebes, 1300 years before the Christian era, and that in the Place de St. Pierre, also from Egypt, has resisted the elements for 3000 years. But between the two extremes of great durability and rapid decay, there are numerous intermediate degrees; for in the same mountain, and even in the same hillock, granites of very different qualities are met with.

Strength of Masonry.

Brickwork, composed with Parker's, Lord Mulgrave's, or Pozzolana cement, will bear 23 tons weight on each superficial foot before the bricks will crack, and 50 tons before it will be totally crushed. Portland stone of the best quality will not split with less than 173¼ tons; and a bedding or joint of Pozzolana mortar is not destructible with that weight. Aberdeen granite resists the greatest weight that can be put upon it, whereas all other granites are crushed by their own superincumbent weight when they exceed 200 feet in altitude.

Waterloo Bridge.

Waterloo bridge is built of Cornish granite, except the balustrades, which are of granite from Aberdeen. The three old bridges are built of Portland stone, and are rapidly decaying. Alternate freezing and thawing greatly injure stone exposed to the river. The price of a cubic foot of stone is doubled

and trebled according to size, as well in the quarrying as in the carriage and setting.*

Menai Bridge at Bangor Ferry.

The span of this hanging arch is 580 feet; depth of the arch, 50 feet; height of the pillars above the roadway, 53 feet; height of the roadway above the level of high water, 100 feet, so that vessels may sail under the bridge. The base of the pillars is founded on a rock near the level of low water, so that from the base to the top of each suspending pillar is 160 feet.

The chains are bent over the pillars at the same angle with which they hang on the arch, and take the ground about 380 feet on each side of each pillar, where they are bent at an angle, and carried in a sloping direction forty feet into a square tunnel, driven out of the solid rock, at the bottom of which they are made fast to strong cast iron plates, butting against the rock.

Highest Edifices.

	Feet.
Pyramid of Gizeh	543
Steeples of the Cathedral at Cologne . .	501
Steeple of the Minster at Ulm	481
Cathedral at Antwerp . .	476
Minster at Strasburgh . .	486
Pyramid of Cheops	452
Cupola of St. Peter's at Rome	431
St. Paul's at London . . .	347
the Jesuits' Church, Paris . .	314
the Invalids, Paris	295

* M. Dupin calculates, that the combined action of the steam-engines now at work in Britain, could raise from the quarries, and place as they now are, all the stones of the great Pyramid in eighteen hours.

Ornaments of Architecture.

The ornaments, rather than the proportions, of architecture are first perceived, and the different orders are known,

The Doric	. .	by its Triglyphs.
Ionic	. .	by its Volutes.
Corinthian		by its Acanthus.

Apothecaries' ornamental Bottles.

The green solution for decorating the front windows of an apothecary's shop, is prepared by adding solution of chromate of potash to ammoniacal sulphate of copper.

Beards.

If people were to go naked, attention would be paid to the figure, and not to the face. The grand distinction in the aspect of the male figure is destroyed by the custom of shaving the beard, which gives an air of dignity even to an ugly countenance. By shaving the beard, and wrapping up the neck, the virility of the human appearance is limited to the external clothing.

The Hat.

In Lord Clarendon's essay on the decay of respect paid to old age, he says, that in his younger days he never kept his hat on before those older than himself, *except at dinner.*

Natural Postures.

With respect to the natural position and movement of the feet, the fashion of turning them outwards is contrary to nature, as may be seen from the structure of the bones, and from the weakness consequent on that mode of standing. To this may be added the

erect position of the head, the projection of the chest, the walking with straight knees, and many such actions, which are merely the result of fashion, but what nature never warranted.

The predominant Passion.

It has been remarked that the predominánt passion may generally be discovered in the countenance, because the muscles by which it is expressed, being almost perpétually contracted, lose their tone, and never totally relax, so that the expression remains when the passion is suspended. Thus an angry, disdainful, a subtle, and a suspicious temper, are displayed in characters that are almost universally understood.

The Phelieben.

Thomas Rawlinson, an iron-smelter and an Englishman, was the person who, about or prior to A. D. 1728, introduced the phelieben, or short kilt, worn in the Highlands. This fact, very little known, is established in a letter from Ewan Baillie, of Oberiachan, inserted in the Edinburgh Magazine for 1785, and also by the Culloden Papers.

MINERALOGY, &c.

The Doctrine of Minerals; the Natural History of the Mineral Kingdom. The Science which brings us acquainted with the various relations under which Minerals are discovered. It comprises the Study of all Solid Inorganic Substances found naturally in the Earth or on its Surface.

Systems of Mineralogy.

Notwithstanding the labour and talents that have been employed to form systems of mineralogy conformable to natural and fixed principles of arrangement, it must be confessed much remains that is arbitrary and uncertain in them all. Writers are not agreed as to the principles on which a mineralogical system should be constructed, whether on the external character, or the chemical composition; nor do they even agree in the definition of the essential characters which constitute mineral species.

The Three Kingdoms.

Linnæus says, "*minerals* grow, *vegetables* grow and live, *animals* grow, live, and move."

Minerals.

All minerals are probably only saline compounds.

Except gray, green is the most abundant colour in

the mineral kingdom, and it is manifestly so in the vegetable.

The Electro-Chemical Theory of Mineralogy.

We are taught to seek in every compound body for ingredients of opposite electro-chemical principles, whose combinations cohere with a force in proportion to the degree of opposition in the electro-chemical nature of the ingredients. In every compound body there are one or more electro-positive, and one or more electro-negative ingredients. By the first are understood such as have inflammable bodies or salts for bases, and by the last the oxygen and oxides that go to the negative pole of the voltaic battery. In other words, every substance called a basis in chemical combination, must have another that acts the part of an acid, though not distinguished by the usual characters or tests.

With the assistance of the above theory we discover a numerous class of minerals, resembling salts in appearance, in which silex acts the part of an acid, and of course an electro-negative ingredient.

Silex is the most abundant substance found in the crust of the earth, and as an acid possesses the property of forming *siliciates* of various degrees of saturation; the most general are those in which the silex contains the same quantity of oxygen as the base.

The mineralogical arrangement of Berzelius, is founded on the order of the electro-chemical properties of bodies, beginning with the most electro-negative, which is oxygen, and terminating with the most electro-positive, potassium; and placing every compound body according to its most electro-positive ingredients.

If one class of stony bodies consists of salts, in which silex performs the functions of an acid, combining with them in definite proportions, the discovery

of these proportions is a most important step towards the advancement of mineralogy to the dignity of a demonstrative science.

Metallic Veins.

The veins which afford metallic substances are fissures more or less vertical, filled with a material different from the rock in which they exist, and generally extending in an east and west direction.

A brown powder at the surface of a vein always indicates iron, and often, also, tin; a pale yellow powder, lead; and a green colour in a vein, or in water, denotes the presence of copper.

Silver is known to be found in association with certain limestones only, and where these cease it will be sought for in vain.

Dolcoath Mine.

Dolcoath mine, in Cornwall, is 456 yards deep, and is still very productive.

Gold.

The total quantity of gold produced annually throughout the world has been estimated at 1,240,000 ounces, but it appears too large an estimate, considering how unproductive the South American mines have become within the last 30 years.

In procuring the pure metal the rough ores of gold are first broken in the stamping mill and washed, by which the lighter and earthy parts are separated. They are then submitted to the action of mercury, which dissolves the gold, and a process of distillation afterwards separates the amalgam, and the gold is produced in a state of comparative purity.

Solid and ponderous as gold appears to be, Sir Isaac Newton supposes the pores or interstices be-

tween its elementary particles greatly to exceed its material parts.

Iron and Gold.

By what mysterious law of nature does it happen, that gold abounds and iron is scarce in all the equatorial regions, and the reverse is true in the temperate zones.

The Wicklow Mines.

A piece of gold picked up in a bog in Wicklow weighed 22 ounces, and was sold on the spot for 68 guineas. It weighed eight ounces more than the heaviest piece ever got in one lump in South America.

The Wicklow mine was simply a stream work, in which the gold was dispersed in the form of small pebbles and sand, through a bed of gravel, it was consequently soon exhausted.

Crystallization.

Every substance in crystallizing has a tendency to assume a particular figure. Common salt crystallizes in cubes; Epsom salt in six-sided prisms; alum in octohedrons; sugar-candy in oblique four-sided prisms with wedge-shaped summits.

The new theory of crystallization depends on another, now universally recognized, that of definite proportions.

Rock Salt.

The most obvious hypothesis respecting the formation of rock salt, is that which supposes it was deposited by the sea, or by the desiccation of salt lakes, which formerly covered the present continents. Salt strata also diminish in thickness as they recede from the sea.

The objections aré, that rock salt is much more pure than the contents of sea water, which contains muriate and sulphate of magnesia, sulphate of soda,

and sulphate of lime. Rock salt is also found at great elevations above the sea, and no marine exuvia have ever been discovered in salt strata. Another objection to this hypothesis is, the enormous depth of sea water necessary to the production of a body of rock salt above forty yards in thickness, such as the insulated mountain of rock salt at Cardona in Spain.

Salt Springs.

The salt made at Droitwich supplies nearly one half of England. A salt river twenty-two inches deep, runs about 250 feet under the surface, over a bed of rock salt, whose thickness has not been ascertained. Immediately above this subterranean stream is a bed of gypsum 130 feet thick, which, when penetrated by the borer, permits the water to rise to the surface. The Droitwich springs hold about one-fourth of their weight of salt in solution, no other in England holds more than a ninth.

Inorganic Matter.

The different parts of an inorganic body enjoy an independent existence, while the parts of a body belonging to the organized kingdom depend on their relative situations for the continuance of their structure and properties.

Inorganic bodies can neither boast of youth nor age, parent or child, while organized bodies have the power of reproduction. The first remain for ever quiescent; the last are never stationary. A plant or tree may appear externally fixed, internally there is no rest.

Organized bodies are also distinguished by their integuments, such as the skin, bark, &c. &c.

Heat of Mines.

It is evident that the elevation of a mine above

the level of the sea does not regulate its temperature as it does that of the surface. Water, in the Killingsworth Colliery, at the depth of 1200 feet under the level of the sea, was 74° Fahrenheit, while the air at 436 deep, in the mine of Villapenda, in Mexico, which is more than 3000 feet above the level of the sea, was 85°. In the Mina Purgatoria, the height of which, above the level of the sea, is equal to the Peak of Teneriffe. the air of the mine was 67°.

Diamonds.

The weight of diamonds is estimated by carats, 150 of which are equal to an ounce troy, or 480 grains.

The difference of value between one diamond and another is, generally speaking, as the squares of their respective weights. Thus, the value of three diamonds, of 1, 2, or 3 carats weight respectively, is as 1, 4, and 9.

The average price of rough diamonds is estimated by Jeffries at £2 per carat, and consequently, when wrought, the cost of the first carat, exclusive of workmanship, will be £8, which is the value of a rough diamond of two carats. A wrought diamond of three carats is worth £72; of four carats, £128; of forty carats, £12,000; and of one hundred carats, £80,000.

The Empress Catherine's diamond weighed 195 carats, and it was purchased by her for £90,000 cash, and an annuity of £4000.—The Pitt diamond is the most perfect and beautiful yet known. It weighs 136 carats, and was purchased by the Regent Duke of Orleans for £100,000.

Alumina.

The earth, alumina, (clay,) constitutes some of the hardest gems, such as the sapphire and ruby; but it rarely occurs quite pure. Its presence is known by

an earthy odour that exhales from the substance when breathed upon.

Artificial Diamonds and other Gems.

The base of all artificial stones is a paste composed of silex, potash, borax, oxide of lead, and sometimes arsenic. The best silex is obtained from rock crystal, and the next best from white sand or flint. The following are two receipts for making a good paste :—

No. 1.

	Grains.
Rock crystal	4056
Minium (red lead)	6300
Pure potash	2154
Borax	276
Arsenic	12

No. 2.

Sand	3600
Ceruse (white lead)	8508
Potash	1260
Borax	360
Arsenic	12

The Pearl.

The pearl is a morbid secretion of the avicula marantifera, and, like shells, is composed of carbonate of lime, united with a small portion of animal matter.

GEOLOGY.

A Description of the Structure of the Globe, of the relative Situations of Rocks and Minerals, of their Connexion with each other, and of the Changes which they are undergoing, and have undergone.*

Rocks.

A geological arrangement of rocks is founded on the great relations which they bear to each other, and to the general structure of the earth. They are usually separated by geologists into two grand divisions, distinguished by the names of primary and secondary.

The *primary* rocks are mostly composed of pure crystalline matter, and contain no fragments of other rocks.

The *secondary* rocks or strata consist only partly of crystalline matter, and contain fragments of other rocks and strata, and often abound with the remains of vegetables and marine animals, and sometimes contain the remains of land animals.

The primary rocks are generally arranged in large masses, or in layers vertical to, or more or less inclined to the horizon.

The secondary rocks are generally disposed in strata, parallel or nearly parallel to the horizon.

* It is scarcely half a century since Geology began to be cultivated scientifically; the prior theories of the earth could only be regarded as amusing speculations, unsupported by existing phenomena.

*Primary Rocks.**

The number of primary rocks commonly observed in nature are eight.

1. Granite—which is composed of quartz, felspar, and mica. When these bodies are arranged in regular layers in the rock, it is often called gneiss.

2. Micaceous Schistus.—This is composed of quartz and mica, arranged in layers, which are usually curvilinear.

3. Sienite (or Syenite).—Consisting of the substance called hornblende and felspar.

4. Serpentine.—This is composed of felspar, and a body named resplendent hornblende, and their separate crystals are often so small as to give the stone an uniform appearance. This rock abounds in veins of a substance named steatite, or soap rock.

5. Porphyry.—Consists of crystals of felspar embedded in the same material, but usually of a different colour.

6. Granular Marble.—Consisting of crystals of carbonate of lime, and which, when its colour is white and texture fine, is the material used by statuaries.

7. Chlorite Schist.—This is composed of chlorite, a green or gray substance, somewhat analogous to felspar and mica.

8. Quartzoze Rocks.—Consisting of quartz in a granular form, sometimes united to small quantities of crystalline elements, which have been mentioned as belonging to other rocks.

* Geology being still in its infancy, and progressive, the early systematic arrangements must necessarily undergo many modifications, until the science approaches nearer to perfection, and its nomenclature acquires greater stability. This will account for an apparent obscurity and confusion in some of the definitions, which are disputed and maintained by different theorists; still they will furnish the reader with a general notion of the meaning attached to them, which in a work of this nature is all that is wanted.

Secondary Rocks.

These are more numerous than the primary, but twelve varieties include all that are usually found in the British isles. They are always found recumbent on the primary.

1. Grawaucke.—This consists of fragments of quartz, or chlorite schistus, embedded in a cement principally composed of felspar.

2. Siliceous Sandstone.—Consisting of fine quartz sand, united by a siliceous cement.

3. Limestone.—This consists of carbonate of lime, more compact in its texture than granular marble, and often abounding with marine exuviæ.

4. Aluminous Schist (or Shale).—Consisting of the decomposed materials of different rocks, cemented by a small quantity of ferruginous or siliceous matter, and often containing the impression of vegetables.

5. Calcareous Sandstone.—Calcareous sand cemented by calcareous matter.

6. Iron-stone.—This is formed of nearly the same materials as aluminous schist or shale, but containing a much larger quantity of oxide of iron.

7. Basalt.—Consisting of felspar and hornblende, with materials derived from the decomposition of the primary rocks. The crystals are generally so small as to give the rock a homogeneous appearance, and it is often disposed in very regular columns, having usually five or six sides.

8. Bituminous—or common coal.

9. Gypsum—or sulphate of lime, and often containing sand.

10. Rock-salt.

11. Chalk, which usually abounds with the remains of marine animals, and contains horizontal layers of flints.

12. Plum-pudding-stone.—This consists of pebbles cemented by a ferruginous or siliceous matter.

Primitive Rocks.

Geologists having found that a certain class of rocks contain no animal or vegetable remains, term them primitive, or primary, as having in their opinion been formed before the organic kingdom was called into existence.

Transition Rocks.

Upon the primitive rest another class, called by Werner *transition* rocks, because he supposed them to have been created when the world was passing from an uninhabited to an inhabited condition, and because they contain petrifactions and zoophytes which do not now exist. No remains of vertebrose animals have been detected.

Floetz Rocks.

Upon the transition rocks lies another and more numerous class, called *floetz* rocks. Of these the older enclose the remains of animals, which not being found now, are supposed to be extinct. The newer of this class contain the remains of animals which approach to, but are not actually the same as, those that inhabit the present seas. The still more recent of the floetz rocks, as well as the *alluvial* formation incumbent on them, contain the remains of animals not to be distinguished from those now existing. The latter also encloses the remains of large land animals. No human remains have hitherto been discovered among extraneous fossils in any solid rock, which is not decidedly, both in respect to situation and composition, of very late date.

Extinct Beings.

The varieties in the characters of the extinct beings are not capriciously distributed, but correspond tolerably distinctly with the order of their position,

approaching more and more, from the oldest to the newest formations, to those of living bodies that now exist on the surface.

If we examine the secondary rocks, beginning with the most ancient, the first organic remains that present themselves are the aquatic plants, and large reeds, but of species different from ours. To these succeed madrepores, encrinites, and other aquatic zoophytes of the simplest forms, and attached to one spot, partaking in some measure of the nature of vegetables.

Posterior to these are orthoceratites, ammonites, and other molluscæ, still very simple in their forms, and entirely different from any animals now known. After these some fishes appear, and plants, consisting of bamboos and ferns, increase, but still differing from any existing ones.

In the next period, with an increased number of extinct species of shells and fishes, we first meet with amphibious and oviparous quadrupeds, such as crocodiles and tortoises, and some reptiles, as serpents, which prove that dry land now existed.

As we approach the newest of the solid rock formations, we find lamantins, phocæ, and other cetaceous and mamniferous sea animals, with some birds, while in the newest of these formations we find the remains of herbivorous land animals of extinct species, the palæotherium, anaplotherium, &c. and of some birds, and fresh-water shells.

In the lowest beds of loose soil, and in peat-bogs, are found the remains of the elephant, rhinoceros, hippopotamus, elk, &c., of different species from those now existing, but appertaining to the same genera.

Lastly, the bones of species which are apparently the same with those now alive, which are never found except in the very latest alluvial depositions, in peat-beds, in the fissures and caverns of certain

rocks, or at small depths below the present surface. Human bones are never found, except among those of animal species now living, and in situations which show that they have been, comparatively speaking, recently deposited.

The Chemical and Mechanical Deposits of Werner.

By mechanical deposits are understood sand, gravel, and whatever bears the marks of fracture and attrition.

By chemical deposits are understood, such as are regularly crystallized, or which have a tendency to crystallization, and in which the action of mechanical causes cannot be traced.

The primitive rocks contain none but chemical deposits, and are entirely composed of them.

The intermediate rocks (or transition) contain a mixture of both, and also some vestiges of organized bodies.

The secondary rocks consist almost entirely of mechanical deposits, or of the remains of such bodies, with little of the chemical.

The Constituents of Primitive Rocks.

The principal constituent parts of primitive rocks are quartz, felspar, mica, limestone, and hornblende, which minerals compose nearly the whole mass of the upper coat of the earth. Of these the quartz, mica, and hornblende, occur together in various states of aggregation, while the limestone occurs in beds of greater or lesser extent.

Characters of Rocks.

The primary characters by which alone the nature of a rock or mineral mass, simple or compound, can be

identified, are those of its mineral composition, texture, the relative disposition of the component minerals, (if a compound rŏck,) its internal structure, and natural divisions.

The colour, lustre, fracture, hardness, fusibility, and specific gravity of rocks, are obviously determined by their qualities of mineral composition and texture, and must vary with them; they are consequently secondary qualities, not characteristics. Of the primary characters, mineral composition is the most important.

Granite.

A primary unstratified* rock, consisting of felspar, quartz, and mica. It is found almost invariably under all the others, yet it occupies the highest points of the earth's surface. It never contains any organic remains. The felspar of granite is usually white, and most commonly greyish yellowish white; also reddish, or milk white, or flesh red.† It is seldom grey, yellowish, or green.

The quartz is usually grey, seldom milk white, and usually translucent.

The mica is commonly grey, and sometimes dark brown, or nearly black.

The felspar of granite has usually a vitreous lustre, and perfectly foliated fracture; yet in some varieties it passes into earthy, with loss of its lustre and hardness, to the state of porcelain earth.

The mica of granite is also sometimes decomposed by exposure to the atmosphere, but the quartz is never altered.

* The unstratified rocks, under a great variety of form, may be all reduced to the two grand divisions of granite and trap. Granite may be called the backbone of the earth, and from it all the hottest springs issue.

† This conveys no clear idea of the substance, and shows the difficulty of rendering the subject intelligible by mere description.

By the disintegration and decomposition, the felspar of granite is changed into clay, the quartz grains into sand, while the mica is broken down and mixed with the clay and sand.

Basalt and Lava.

Dolomieu observes, with respect to basalt, that many subjects of different natures so much resemble each other, in analysis as well as in appearance, that it is difficult to fix the application of the name to any one in particular. That all basalt has been in a state of fusion is highly probable, it melts at such a low temperature.

Basalt affects the magnetic needle, containing about twenty per cent. of iron, besides many heterogeneous substances, but it is not otherwise metalliferous. When exposed to the weather, it gradually crumbles down into a fine black mould, which constitutes a very fertile soil, and it is to this rock that some of the richest parts of Scotland owe their fertility.

Lava retains its heat for a very long period of time. Spallanzani saw a piece of wood take fire in lava three years and a half after it was thrown out, and at a distance of two leagues from the crater.*

Whinstone and Lava.

Sir James Hall completely established the identity of whinstone and lava. He also ascertained that carbonate of lime might be readily fused if it were under a pressure equivalent to about a mile and a half of sea.

* The horizontal stratification of basalt, and its gradation downwards through the softer substance, wacké into clay, convinced Werner that it was not a volcanic product. Von Buch, on the other hand, considers basalt and porphyry as the dwelling-place of volcanoes.

Strata.

When the position of the beds of transition rocks are examined on a great scale, they are found to occupy immense hollows in the primitive rocks. Old red sandstone fills up the hollows of the transition, and occasionally of the primitive. The independent coal, chalk, gypsum, and alluvial deposits fill up the other hollows, and the process is still going on.

In a depth of less than five hundred yards, eighty different strata have been counted.

Aqueous Origin.

The formation of quartz, chalcedony, and calcareous spar, may be witnessed, the last with great rapidity, both by infiltration, and by solutions of carbonate of lime. Chalcedony is produced in the first way, quartz in both.

The Wernerian or Neptunian Theory.

Werner's theory assumes as a first principle, that our globe was once covered with a chaotic compost, holding either in solution or suspension the various rocks and strata which now present themselves at its exterior crust.

This fluid is supposed first to have deposited such bodies as it held in chemical solution, by which process a variety of crystallized rocks (such as granite, &c.) were formed. In these no vegetable or animal remains are found, not even rounded pebbles; but in the strata which lie on the crystalline, shells and fragments occasionally occur, in consequence of which they have been termed transition strata, and it is conjectured that about this time began the peopling of the ocean.

The waters of the earth now began to subside more rapidly, and finely divided particles were deposited upon the transition rocks, chiefly in horizontal

layers. These are termed by Werner floetz and secondary rocks, and abound in organic remains.*

The Plutonic, Huttonian, or Igneous Theory.

The Huttonian system does not carry us back to the original formation of the globe. It supposes that the present *dry land* was at a former period the *bed of the ocean;* consequently, the *present* strata were not precipitated from a chemical solution, being rather composed of the ruins of a former world.

Granite, the oldest Wernerian rock, is supposed by the Plutonists to be of more recent formation than the incumbent strata, being regarded as a substance that has been erupted from great depths in a state of igneous fusion, bursting through the strata in some parts, and upheaving the whole from their submarine situation. Trap rocks are conjectured to have been formed by volcanic agency under the pressure of an incumbent ocean.

Geological Systems.

The leading positions in which the Huttonian and Wernerian systems agree are, that the present continents have been covered with the ocean; and that the materials of which the rocks and strata were composed, were deposited by an aqueous fluid. But from these points of agreement they widely diverge in their explanation of the causes by which the continents were laid dry, the mountains elevated, and the materials converted into stone.

* The principal objection (for there are many others) to the Wernerian theory is, that by far the greater part of the substances of which rocks are composed, are not soluble in water, or require so large a proportion for their solution, that the capacity of the whole globe, were it a hollow sphere, would be too small to contain a sufficient quantity of the aqueous menstruum. Indeed latterly the votaries of Neptune have nearly abjured their errors, and ranged themselves under the banners of Pluto.

Different Effects of Combustion and Ignition.

Bodies exposed to heat in contact with the atmosphere undergo a chemical change; their more volatile parts are driven off, and the inflammable parts combine with oxygen, but in a state of mere ignition; under great pressure, and confined from all access to air, water, &c., the same bodies will remain red-hot for ages without undergoing any change but that of simple fusion, whereas by combustion a chemical change is effected.

Igneous Origin.

Rocks known to be the produce of fire may be limited to granite, the trap rocks, and the volcanic rocks. Perhaps gneiss, micaceous schist, and other primary strata, may be added.

Theory of successive Creations.

The discovery of animals peculiar to certain formations, and the general agreement with each other of the fossils of the same formations, have led to the inference that these several formations were the consequences of successive changes effected on the earth's surface, and that their contained fossils are the preserved remains of several creations, which had been successively formed, to accord with the existing condition of the planet under its several changes.

In the lower and early formed strata are the remains of unknown vegetables, and in the mountain limestone accumulations of crinoidal and terebratular remains, which do not now exist, as also multilocular shells, such as ammonites and belemnites, which do not now exist except in the instance of the nautilus.

The fossils of the next superior formation (the lias), yield strong proofs of their having been the production of a distinct creation, the shells (ostrea, &c.) differing essentially from those of the preceding

formation. But the most decided proof of these fossils being the remains of another world, and of a distinct creation, is their containing the relics of a tribe of enormous marine animals: quadrupeds possessing the blended structure of fish and lizard, viz. the ichthyosaurus, the plesiosaurus, &c., no traces of these having been discovered in any preceding strata.

The fossil remains throughout the succeeding higher formations of oolite, green sand, chalk, and clay, show new genera both of saurian and testaceous animals, among the former crocodiles, monitors, &c., and among the latter numerous turbinated and turretted kinds.

But when we follow on the surface of the vast mass of upper clay, the traces of diluvian torrents, and the desolation that accompanied the last grand catastrophe which the planet appears to have sustained, we then find the remains of another creation, the terrestrial quadrupeds, a new order of animals, differing in almost every respect from those that preceded them, and of which not a single bone is to be found in any of the prior formations. In this grand mutation only some species of quadrupeds (such as the elephant, rhinoceros, and hippopotamus) were entirely removed, while other genera of quadrupeds (the mastodon, palæotherium, and anoplotherium) were completely annihilated throughout all their species.

These changes in the state of the planet, and this partial destruction of quadrupeds, appear to have been succeeded by the creation of man, and such other animals as were fit inhabitants of the earth under its existing condition.

Subsequently the Mosaic deluge took place, but without any great subversive violence,* such as

* A different opinion is expressed elsewhere. See "Deluge." See also "Surface of the Earth before the Deluge."

would essentially have disturbed the strata, or mineralized its victims.

From these several creations it appears that beings have proceeded, gradually increasing in superiority, from testaceous animals to reptiles, marine, and fresh-water amphibia, quadrupeds, and lastly, to man.

Series of Living Forms.

First, a few plants of very doubtful character in the oldest graywacke slate; then, zoophytes and crustaceous mollusca with trilobites; afterwards, an abundant creation of cotyledonous and monocotyledonous plants; following these, a great increase of marine testaceous and crustaceous molluscæ and zoophytes; then, fishes, birds, and oviparous quadrupeds, comprehending the saurian or lizard family; afterwards, dicotyledonous plants; then, marine mammalia, and the present race of animals. The fossil remains of these lie buried in beds that overlie each other, nearly in the order above detailed, and between beds or strata are generally found others which do not contain any fossil remains, and which mark the flux of considerable intervals of time in the process of their extinction.

The Deluge.

De Luc, Dolomieu, and Cuvier are of opinion that reciprocal exchanges of land and water took place at the deluge; that catastrophe having buried all countries that were previously inhabited by man and other animals, while at the same time it laid dry the bed of the last ocean, which now forms the countries at present inhabited.

Revolutions in the Animal Kingdom.

Recent geological discoveries lead to the conclusion, that the revolutions which have taken place in

the animal kingdom, have been produced by the changes which accompanied the successive depositions of the strata. According to this view of the matter, the animals and vegetables with which the earth is at present covered, could not have lived at the period when the transition rocks were forming. A variety of changes have taken place in succession, giving to the earth its present character, and fitting it for the residence of its present inhabitants, which the progress of the same system may again render unfit.

Agreement of Fossils with their Strata.

Peculiar fossils are found to characterize particular strata, so that the strata may in many respects be predicated from the organized fossils found there.

If a collection of fossils from the chalk of Flamborough Head, from the cliffs of Dover, from Paris, or from Poland, be examined, eight or nine out of ten species will be found the same. The same echinites will be found associated with the same shells, and nearly half of these will be found to belong to divisions of that family (èchinites) unknown in a recent state, and indeed in any other fossil bed except chalk.

If fossils found in the carboniferous limestone be inspected, from whatever locality, they will be found to agree with each other in the same manner, that is to say, the same coral, the same encrinites, terebratulæ, spiriferæ, &c. will be discovered.

But, if, on the other hand, the collection from the chalk be compared with that from the mountain lime, not one instance of specific agreement will be perceived, which proves that they are not irregularly or accidentally distributed, each formation containing an association of species, peculiar in many instances to itself.

Comparative Antiquity of Fossils.

All geologists now agree in thinking, that the generations of organized bodies, which have successively inhabited the surface of the earth, differ from the present generation in proportion as their debris are further removed from the surface of the earth, or, which comes to the same thing, in proportion as the periods at which they have lived are more remote from the present time.

It has been ascertained by Cuvier, that the bones of the species similar to those which still exist alive, are never found in a fossil state, except in the latest alluvial depositions, and from their superficial position they are always in a worse state of preservation than those of an earlier date.

For a long period the organic productions of the globe appear to have been principally marine.

Human Fossils.

Among so many organized remains of a former world, not any traces of human remains were ever known to be found, a fact the more remarkable, as, were the present world destroyed, the quantity of human remains would much exceed any others, which circumstance tends singularly to reconcile the Mosaic with the scientific geology, the revealed with the natural account of time.*

Human bones have lately been discovered in loam, in gypsum caves, associated with the remains of the rhinocerus, fossil horse, &c., a fact which goes to prove that the human species was in existence, when these animals inhabited Europe, and the temperate regions.

* The human petrifaction found at Guadeloupe, and now at the Museum, is not an exception, it having been discovered near the surface, not in any of the old formations.

Fossil Elephants.

The fossil remains of the elephant belong to a species different from any of those now living, or known to exist on the globe; and although there are many genera containing both extinct and recent species, there are other genera which have no living examples, such as the mastodon, anoplotherium, and palæotherium. Their remains are found in the superficial deluvial detritus, consisting either of gravel, loam, or clay, and are never embedded in any of the regular strata.

Antediluvian Bears.

The total quantity of animal matter that now lies within the cave of Kuloch in Germany cannot be computed at less than 5000 cubic feet. Allowing two cubic feet of dust and bones for each individual animal, we shall have in this single vault the remains of at least 2500 bears, a number which may have been supplied in the space of 1000 years, supposing a mortality of 2½ bears (who had their dens within the cave) per annum.

Fossil Fish.

Saussure mentions a curious fact respecting the impressions of fish met with on the hard schistose marl of Monte Bolca, near Verona; namely, that the impression of 105 different species has been recognized, of which

27	belong to the European seas.
39	to the Asiatic seas.
3	to the African seas.
18	to the South American seas.
11	to the North American seas.
7	to fresh-water lakes and rivers of different parts of the world.
105	

Surface of the Earth before the Deluge.

It is probable that the antediluvian surface of the earth, or at least of a large portion of the northern hemisphere, was the same with the present; since those tracts of dry land in which we find the ossiferous caves and fissures must have been dry also, when the land animals, whose bones are still found, inhabited or fell into them, during the period preceding the inundation by which they were extirpated.

The climate of Siberia when the mammoth flourished there, was probably of the same temperature that it is now, the animal found among the ice having evidently been furnished with a covering capable of resisting extreme cold. In fact, there is every reason to suppose, that the various fossil organic remains contained in rocks of different kinds belong to animals and vegetables that formerly lived in the countries where these remains are now discovered.

The Antediluvian Flora and Climate.

There is now a difference of at least 41° of heat (mean temperature) between the parallels of latitude in which coal has been discovered, yet at the time of the coal formation, as is proved by the vegetable remains, the Floras of these remote parallels must have been the same, both as to genera and species; latitude, longitude, or even elevation, not appearing to have any effect in diversifying them.

Sand, Clay, and Limestone.

Siliceous, argillaceous, and calcareous substances, (more familiarly known under the common names of sand, clay, and limestone,) constitute $\frac{9}{10}$ths of the mineral masses forming rocks; the remaining $\frac{1}{10}$th consists of compound rocks, composed principally of only four ingredients; viz. quartz, felspar, mica and hornblende. These great masses contain, dispersed

through them in comparatively small quantities, all the substances comprehended within the limits of the mineral kingdom.

Rocks deeply seated below the earth are converted into clay.

Coal.

In the west of England trials have been made to reach coal, by shafts sunk through strata now known to occupy invariably an inferior position to the coal measures where both are present. Where we find in the map greywacké, transition limestone, mountain limestone, or old red sandstone, depicted as the superficial rock, it would be absurd to sink for coal.

That coal is of vegetable origin seems now generally admitted.

Chalk.

Chalk has not been found in any part of South America or Africa yet explored. It seems confined to the North of Europe and the Crimea.

The formation of flint has been much speculated upon, but no plausible theory has as yet been invented to account for it.

One opinion entertained of flint is, that possibly it may have been deposited stalactically in strata of chalk, by aqueous infiltration of the siliceous particles; another opinion is, that it has been forcibly injected while ignited and in a fluid state between the chalk strata.

The decomposition of pyrites in chalk produces sulphate of lime, and in aluminous slate, alum.

London Gravel.

By exposure to the weather flint loses its dark grey or black colour, and becomes ochry, probably in consequence of further oxidation of the iron originally contained in it, and hence the colour of those beds of gravel met with in the vicinity of London,

and of all the districts where chalk strata occur; these beds consisting principally of fragments of the common black flint altered by exposure to the air, and very uniformly worn; but still the properties sufficiently correspond to establish their identity.

Sandstone and Limestone Hills.

The sandstone and limestone hills in Derbyshire and North Wales may easily be distinguished at a distance in Summer, by the different tints of the vegetation. The grass on the sandstone hills usually appears brown and burned up, while that on the limestone hills is green and flourishing.*

Volcanoes.

Werner thinks there are 193 volcanoes known to be in activity on the face of the earth, besides a much greater number extinguished, or dormant, or under the sea.

The simultaneous eruptions of volcanoes, and occurrence of earthquakes, in places distant from each other, might be adduced to prove subterranean communication between the volcanoes.

The enormous volcanic cones of Cotopaxi, Pechinga, Tanguragua, &c. in South America, never throw out lava, but frequently ashes, scoriæ, and pumice, and sometimes immense quantities of muddy water.

It would appear that, in America, all elevations higher than Montblanc are entirely composed of volcanic matter.

* Carbonate of lime (common limestone) is easily recognized by its softness, and by its effervescence with dilute sulphuric acid. If exposed to heat under pressure, so as to prevent the escape of gazeous matter, it fuses and retains its carbonic acid. None of the other carbonates exist in such large mineral masses.

No volcano, strictly so called, is known with certainty to exist in Africa; but in what are called the African Isles, there are several.

Not one volcano is to be found in the interior of any continent, or, indeed, any where remote from the sea.

The Island of Owhyhee.

Owhyhee, covering a space of 4000 square miles, is one complete mass of lava in different stages of decomposition, perforated with innumerable apertures in the shape of craters; in fact this island is an enormous hollow cone, 18,000 feet high, over a vast furnace, situated in the heart of this gigantic marine mountain.

Subterranean Communication of Volcanoes.

During the eruptions of the great volcano of Tomboro, on the island of Sumbhawa, in the East Indies, on the 11th of April, 1816, the noise was so loud in the neighbourhood of Mocomoco, although the distance exceeded 1400 miles, and so much resembled discharges of artillery, that the chiefs of the interior, supposing Fort Anne, at Mocomoco, was attacked from the sea, armed their followers and marched down in a body to assist the garrison.

Mud Volcanoes.

On the plains of Grobogang, in the island of Java, are some remarkable mud volcanoes, having, at a distance, the appearance of the surf breaking over rocks. On approaching them, (in 1815,) an elevated plain of mud is perceived about two miles in circumference, in the centre of which immense bodies of salt mud are thrown up, to the height of ten or fifteen feet, in the shape of large globes or bubbles, which are continually throwing up and bursting seven or eight

times in a minute. As these globes burst, they scatter the mud, sometimes to the amount of two or three tons, from the centre. This mud is cold on the surface, but said to be warm within.

Extinct Volcanoes.

By extinct volcanoes, is understood such as have never, according to any human tradition or historical record, been known to have been at any period in a state of activity, yet whose products, still existing demonstrate that they are of volcanic origin. The most remarkable examples of these are in the province of Auverge, in France.*

Earthquakes.

The frequency of earthquakes in volcanic countries, and when they occur in non-volcanic countries remote from volcanic fires, the coincidence of their occurrence with distant volcanic eruptions, strongly indicate that they are influenced by the same cause. It is a remarkable circumstance, also, that the shocks of earthquakes are most severe in non-volcanic countries, such as Lisbon and the Caraccas.

Source of Volcanic Fire.

Water seems to be a necessary agent in the production of volcanic fire, for only extinct volcanoes are found far inland. The most active are in the immediate vicinity of the sea, and some are actually submarine. The matter that feeds them does not seem to be universally diffused, but rather collected in particular spots. Hence they almost always exist in groups, yet the action of one of the volcanoes of the same group is found to be completely independent

* Homer says nothing about the eruptions of Etna; the earliest historian that mentions them is Thucydides.

of that of the others,—Stromboli being asleep, while Ætna is raging. The fire is probably seated at some considerable distance under the surface, but the erupted matter does not appear to come from a very great depth. The source of this fire remains unknown, notwithstanding many plausible conjectures. Beds of coal and pyrites do not account for it, neither do the pure metallic basis of potass and soda.

Temperature of the Earth at various Depths.

At 10 fathoms . . .	50·18°
20 to 30 . . .	60·98
90 to 100. . . .	69·08
150 to 160. . . .	75·02
150 to 200. . . .	75·92
230	78·14
240	82·04

At the bottom of the mine at Dolcoath, in Cornwall, at 240 fathoms depth, there issues from a vein a very abundant jet of water, the constant temperature of which is 82°.

Hot Springs and Central Heat.

In the coal-mine of Killingworth, the deepest in Britain,* the annual temperature at the surface is 48°; at 300 yards below the surface, 70°; and at 400 yards, 74° Fahrenheit.

In the British mines generally, the increment of temperature is about one degree for every 15 yards of descent; in Saxony, for every 22 yards of descent.

Taking 20 yards as a mean, if the increase follow the same arithmetical ratio to a considerable depth, we ought to find the temperature of the Bath waters

* The deepest excavation near London, is the well sunk by the present Earl Spencer, at Wimbledon, which is 563 feet deep.

(116°) at 1320 yards below the surface of the earth, and that of boiling water at 3300 yards, or nearly two miles.*

The frequency of hot springs from 80° to 120° Fahrenheit, the variety of those that approach the boiling point, and the constancy of temperature in them all, are circumstances remarkably consistent with this hypothesis; the following conclusions are therefore probable:—

1. That the heat of the interior is always greater than at the surface.

2. That the heat augments progressively as we descend, in a ratio bearing some relation to the depth.

3. That even at moderate depths this heat is greater than the mean heat of the globe ought to be if entirely derived from the sun.

Results of Geology.

The progress of this science establishes beyond all doubt the great catastrophe described in Sacred History, and the concurrent traditions of many ancient nations. It also demonstrates a primitive chaotic state of the globe, in which there was no life,—a succession of living created things, of which man was the last, destined to people the earth, when its surface had assumed a state of order and beauty, fitted for the activity and improvement of an intellectual, progressive, and probationary being.

* Now that we have so effectually explored the Surface of the earth, a voyage of discovery towards its Centre seems very desirable. Many curious discoveries might be made by perforating to the depth of two or three miles, selecting a proper spot to escape, if possible, the inclination of the strata.

LONDON:

[illegible]

[illegible]